Cisco IOS IP SLAs Configuration Guide

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About Cisco IOS Software Documentation

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This document describes the objectives, audience, conventions, and organization used in Cisco IOS software documentation. Also included are resources for obtaining technical assistance, additional documentation, and other information from Cisco. This document is organized into the following sections:

Documentation Objectives

Cisco IOS documentation describes the tasks and commands available to configure and maintain Cisco networking devices.

Audience

The Cisco IOS documentation set is intended for users who configure and maintain Cisco networking devices (such as routers and switches) but who may not be familiar with the configuration and maintenance tasks, the relationship among tasks, or the Cisco IOS commands necessary to perform particular tasks. The Cisco IOS documentation set is also intended for those users experienced with Cisco IOS software who need to know about new features, new configuration options, and new software characteristics in the current Cisco IOS release.

Documentation Conventions

In Cisco IOS documentation, the term *router* may be used to refer to various Cisco products; for example, routers, access servers, and switches. These and other networking devices that support Cisco IOS software are shown interchangeably in examples and are used only for illustrative purposes. An example that shows one product does not necessarily mean that other products are not supported.

This section contains the following topics:

Typographic Conventions

Cisco IOS documentation uses the following typographic conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination **^D** or **Ctrl-D** means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
string	A string is a nonquoted set of characters shown in italics. For example, when setting a Simple Network Management Protocol (SNMP) community string to *public*, do not use quotation marks around the string; otherwise, the string will include the quotation marks.

Command Syntax Conventions

Cisco IOS documentation uses the following command syntax conventions:

Convention	Description
bold	Bold text indicates commands and keywords that you enter as shown.
italic	Italic text indicates arguments for which you supply values.
[x]	Square brackets enclose an optional keyword or argument.
...	An ellipsis (three consecutive nonbolded periods without spaces) after a syntax element indicates that the element can be repeated.
|	A vertical line, called a pipe, that is enclosed within braces or square brackets indicates a choice within a set of keywords or arguments.
[x | y]	Square brackets enclosing keywords or arguments separated by a pipe indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments separated by a pipe indicate a required choice.
[x {y | z}]	Braces and a pipe within square brackets indicate a required choice within an optional element.

Software Conventions

Cisco IOS software uses the following program code conventions:

Convention	Description
`Courier font`	Courier font is used for information that is displayed on a PC or terminal screen.
`Bold Courier font`	Bold Courier font indicates text that the user must enter.
< >	Angle brackets enclose text that is not displayed, such as a password. Angle brackets also are used in contexts in which the italic font style is not supported; for example, ASCII text.
!	An exclamation point at the beginning of a line indicates that the text that follows is a comment, not a line of code. An exclamation point is also displayed by Cisco IOS software for certain processes.
[ ]	Square brackets enclose default responses to system prompts.

Reader Alert Conventions

Cisco IOS documentation uses the following conventions for reader alerts:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Timesaver Means *the described action saves time*. You can save time by performing the action described in the paragraph.

Documentation Organization

This section describes the Cisco IOS documentation set, how it is organized, and how to access it on Cisco.com. It also lists the configuration guides, command references, and supplementary references and resources that comprise the documentation set. It contains the following topics:

Cisco IOS Documentation Set

The Cisco IOS documentation set consists of the following:

- Release notes and caveats provide information about platform, technology, and feature support for a release and describe severity 1 (catastrophic), severity 2 (severe), and select severity 3 (moderate) defects in released Cisco IOS software. Review release notes before other documents to learn whether updates have been made to a feature.
- Sets of configuration guides and command references organized by technology and published for each standard Cisco IOS release.
  - Configuration guides—Compilations of documents that provide conceptual and task-oriented descriptions of Cisco IOS features.
  - Command references—Compilations of command pages in alphabetical order that provide detailed information about the commands used in the Cisco IOS features and the processes that comprise the related configuration guides. For each technology, there is a single command reference that supports all Cisco IOS releases and that is updated at each standard release.
- Lists of all the commands in a specific release and all commands that are new, modified, removed, or replaced in the release.
- Command reference book for **debug** commands. Command pages are listed in alphabetical order.
- Reference book for system messages for all Cisco IOS releases.

Cisco IOS Documentation on Cisco.com

The following sections describe the organization of the Cisco IOS documentation set and how to access various document types.

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

New Features List

The New Features List for each release provides a list of all features in the release with hyperlinks to the feature guides in which they are documented.

Feature Guides

Cisco IOS features are documented in feature guides. Feature guides describe one feature or a group of related features that are supported on many different software releases and platforms. Your Cisco IOS software release or platform may not support all the features documented in a feature guide. See the Feature Information table at the end of the feature guide for information about which features in that guide are supported in your software release.

Configuration Guides

Configuration guides are provided by technology and release and comprise a set of individual feature guides relevant to the release and technology.

Command References

Command reference books contain descriptions of Cisco IOS commands that are supported in many different software releases and on many different platforms. The books are organized by technology. For information about all Cisco IOS commands, use the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or the *Cisco IOS Master Command List, All Releases*, at http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html.

Cisco IOS Supplementary Documents and Resources

Supplementary documents and resources are listed in Table 2 on page xi.

Configuration Guides, Command References, and Supplementary Resources

Table 1 lists, in alphabetical order, Cisco IOS software configuration guides and command references, including brief descriptions of the contents of the documents. The Cisco IOS command references contain commands for Cisco IOS software for all releases. The configuration guides and command references support many different software releases and platforms. Your Cisco IOS software release or platform may not support all these technologies.

Table 2 lists documents and resources that supplement the Cisco IOS software configuration guides and command references. These supplementary resources include release notes and caveats; master command lists; new, modified, removed, and replaced command lists; system messages; and the debug command reference.

For additional information about configuring and operating specific networking devices, and to access Cisco IOS documentation, go to the Product/Technologies Support area of Cisco.com at the following location:

http://www.cisco.com/go/techdocs

Table 1 Cisco IOS Configuration Guides and Command References

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS AppleTalk Configuration Guide* • *Cisco IOS AppleTalk Command Reference*	AppleTalk protocol.
• *Cisco IOS Asynchronous Transfer Mode Configuration Guide* • *Cisco IOS Asynchronous Transfer Mode Command Reference*	LAN ATM, multiprotocol over ATM (MPoA), and WAN ATM.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Bridging and IBM Networking Configuration Guide* • *Cisco IOS Bridging Command Reference* • *Cisco IOS IBM Networking Command Reference*	Transparent and source-route transparent (SRT) bridging, source-route bridging (SRB), Token Ring Inter-Switch Link (TRISL), and token ring route switch module (TRRSM). Data-link switching plus (DLSw+), serial tunnel (STUN), block serial tunnel (BSTUN); logical link control, type 2 (LLC2), synchronous data link control (SDLC); IBM Network Media Translation, including Synchronous Data Logical Link Control (SDLLC) and qualified LLC (QLLC); downstream physical unit (DSPU), Systems Network Architecture (SNA) service point, SNA frame relay access, advanced peer-to-peer networking (APPN), native client interface architecture (NCIA) client/server topologies, and IBM Channel Attach.
• *Cisco IOS Broadband Access Aggregation and DSL Configuration Guide* • *Cisco IOS Broadband Access Aggregation and DSL Command Reference*	PPP over ATM (PPPoA) and PPP over Ethernet (PPPoE).
• *Cisco IOS Carrier Ethernet Configuration Guide* • *Cisco IOS Carrier Ethernet Command Reference*	Connectivity fault management (CFM), Ethernet Local Management Interface (ELMI), IEEE 802.3ad link bundling, Link Layer Discovery Protocol (LLDP), media endpoint discovery (MED), and Operation, Administration, and Maintenance (OAM).
• *Cisco IOS Configuration Fundamentals Configuration Guide* • *Cisco IOS Configuration Fundamentals Command Reference*	Autoinstall, Setup, Cisco IOS command-line interface (CLI), Cisco IOS file system (IFS), Cisco IOS web browser user interface (UI), basic file transfer services, and file management.
• *Cisco IOS DECnet Configuration Guide* • *Cisco IOS DECnet Command Reference*	DECnet protocol.
• *Cisco IOS Dial Technologies Configuration Guide* • *Cisco IOS Dial Technologies Command Reference*	Asynchronous communications, dial backup, dialer technology, dial-in terminal services and AppleTalk remote access (ARA), dial-on-demand routing, dial-out, ISDN, large scale dial-out, modem and resource pooling, Multilink PPP (MLP), PPP, and virtual private dialup network (VPDN).
• *Cisco IOS Flexible NetFlow Configuration Guide* • *Cisco IOS Flexible NetFlow Command Reference*	Flexible NetFlow.
• *Cisco IOS High Availability Configuration Guide* • *Cisco IOS High Availability Command Reference*	A variety of high availability (HA) features and technologies that are available for different network segments (from enterprise access to service provider core) to facilitate creation of end-to-end highly available networks. Cisco IOS HA features and technologies can be categorized in three key areas: system-level resiliency, network-level resiliency, and embedded management for resiliency.
• *Cisco IOS Integrated Session Border Controller Command Reference*	A VoIP-enabled device that is deployed at the edge of networks. An SBC is a toolkit of functions, such as signaling interworking, network hiding, security, and quality of service (QoS).

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Intelligent Services Gateway Configuration Guide* • *Cisco IOS Intelligent Services Gateway Command Reference*	Subscriber identification, service and policy determination, session creation, session policy enforcement, session life-cycle management, accounting for access and service usage, and session state monitoring.
• *Cisco IOS Interface and Hardware Component Configuration Guide* • *Cisco IOS Interface and Hardware Component Command Reference*	LAN interfaces, logical interfaces, serial interfaces, virtual interfaces, and interface configuration.
• *Cisco IOS IP Addressing Services Configuration Guide* • *Cisco IOS IP Addressing Services Command Reference*	Address Resolution Protocol (ARP), Network Address Translation (NAT), Domain Name System (DNS), Dynamic Host Configuration Protocol (DHCP), and Next Hop Address Resolution Protocol (NHRP).
• *Cisco IOS IP Application Services Configuration Guide* • *Cisco IOS IP Application Services Command Reference*	Enhanced Object Tracking (EOT), Gateway Load Balancing Protocol (GLBP), Hot Standby Router Protocol (HSRP), IP Services, Server Load Balancing (SLB), Stream Control Transmission Protocol (SCTP), TCP, Web Cache Communication Protocol (WCCP), User Datagram Protocol (UDP), and Virtual Router Redundancy Protocol (VRRP).
• *Cisco IOS IP Mobility Configuration Guide* • *Cisco IOS IP Mobility Command Reference*	Mobile ad hoc networks (MANet) and Cisco mobile networks.
• *Cisco IOS IP Multicast Configuration Guide* • *Cisco IOS IP Multicast Command Reference*	Protocol Independent Multicast (PIM) sparse mode (PIM-SM), bidirectional PIM (bidir-PIM), Source Specific Multicast (SSM), Multicast Source Discovery Protocol (MSDP), Internet Group Management Protocol (IGMP), and Multicast VPN (MVPN).
• *Cisco IOS IP Routing: BFD Configuration Guide*	Bidirectional forwarding detection (BFD).
• *Cisco IOS IP Routing: BGP Configuration Guide* • *Cisco IOS IP Routing: BGP Command Reference*	Border Gateway Protocol (BGP), multiprotocol BGP, multiprotocol BGP extensions for IP multicast.
• *Cisco IOS IP Routing: EIGRP Configuration Guide* • *Cisco IOS IP Routing: EIGRP Command Reference*	Enhanced Interior Gateway Routing Protocol (EIGRP).
• *Cisco IOS IP Routing: ISIS Configuration Guide* • *Cisco IOS IP Routing: ISIS Command Reference*	Intermediate System-to-Intermediate System (IS-IS).
• *Cisco IOS IP Routing: ODR Configuration Guide* • *Cisco IOS IP Routing: ODR Command Reference*	On-Demand Routing (ODR).
• *Cisco IOS IP Routing: OSPF Configuration Guide* • *Cisco IOS IP Routing: OSPF Command Reference*	Open Shortest Path First (OSPF).
• *Cisco IOS IP Routing: Protocol-Independent Configuration Guide* • *Cisco IOS IP Routing: Protocol-Independent Command Reference*	IP routing protocol-independent features and commands. Generic policy-based routing (PBR) features and commands are included.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS IP Routing: RIP Configuration Guide* • *Cisco IOS IP Routing: RIP Command Reference*	Routing Information Protocol (RIP).
• *Cisco IOS IP SLAs Configuration Guide* • *Cisco IOS IP SLAs Command Reference*	Cisco IOS IP Service Level Agreements (IP SLAs).
• *Cisco IOS IP Switching Configuration Guide* • *Cisco IOS IP Switching Command Reference*	Cisco Express Forwarding, fast switching, and Multicast Distributed Switching (MDS).
• *Cisco IOS IPv6 Configuration Guide* • *Cisco IOS IPv6 Command Reference*	For IPv6 features, protocols, and technologies, go to the IPv6 "Start Here" document.
• *Cisco IOS ISO CLNS Configuration Guide* • *Cisco IOS ISO CLNS Command Reference*	ISO Connectionless Network Service (CLNS).
• *Cisco IOS LAN Switching Configuration Guide* • *Cisco IOS LAN Switching Command Reference*	VLANs, Inter-Switch Link (ISL) encapsulation, IEEE 802.10 encapsulation, IEEE 802.1Q encapsulation, and multilayer switching (MLS).
• *Cisco IOS Mobile Wireless Gateway GPRS Support Node Configuration Guide* • *Cisco IOS Mobile Wireless Gateway GPRS Support Node Command Reference*	Cisco IOS Gateway GPRS Support Node (GGSN) in a 2.5-generation general packet radio service (GPRS) and 3-generation universal mobile telecommunication system (UMTS) network.
• *Cisco IOS Mobile Wireless Home Agent Configuration Guide* • *Cisco IOS Mobile Wireless Home Agent Command Reference*	Cisco Mobile Wireless Home Agent, an anchor point for mobile terminals for which mobile IP or proxy mobile IP services are provided.
• *Cisco IOS Mobile Wireless Packet Data Serving Node Configuration Guide* • *Cisco IOS Mobile Wireless Packet Data Serving Node Command Reference*	Cisco Packet Data Serving Node (PDSN), a wireless gateway that is between the mobile infrastructure and standard IP networks and that enables packet data services in a code division multiple access (CDMA) environment.
• *Cisco IOS Mobile Wireless Radio Access Networking Configuration Guide* • *Cisco IOS Mobile Wireless Radio Access Networking Command Reference*	Cisco IOS radio access network products.
• *Cisco IOS Multiprotocol Label Switching Configuration Guide* • *Cisco IOS Multiprotocol Label Switching Command Reference*	MPLS Label Distribution Protocol (LDP), MPLS Layer 2 VPNs, MPLS Layer 3 VPNs, MPLS traffic engineering (TE), and MPLS Embedded Management (EM) and MIBs.
• *Cisco IOS Multi-Topology Routing Configuration Guide* • *Cisco IOS Multi-Topology Routing Command Reference*	Unicast and multicast topology configurations, traffic classification, routing protocol support, and network management support.
• *Cisco IOS NetFlow Configuration Guide* • *Cisco IOS NetFlow Command Reference*	Network traffic data analysis, aggregation caches, and export features.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Network Management Configuration Guide* • *Cisco IOS Network Management Command Reference*	Basic system management; system monitoring and logging; troubleshooting, logging, and fault management; Cisco Discovery Protocol; Cisco IOS Scripting with Tool Control Language (Tcl); Cisco networking services (CNS); DistributedDirector; Embedded Event Manager (EEM); Embedded Resource Manager (ERM); Embedded Syslog Manager (ESM); HTTP; Remote Monitoring (RMON); SNMP; and VPN Device Manager Client for Cisco IOS software (XSM Configuration).
• *Cisco IOS Novell IPX Configuration Guide* • *Cisco IOS Novell IPX Command Reference*	Novell Internetwork Packet Exchange (IPX) protocol.
• *Cisco IOS Optimized Edge Routing Configuration Guide* • *Cisco IOS Optimized Edge Routing Command Reference*	Optimized edge routing (OER) monitoring; Performance Routing (PfR); and automatic route optimization and load distribution for multiple connections between networks.
• *Cisco IOS Quality of Service Solutions Configuration Guide* • *Cisco IOS Quality of Service Solutions Command Reference*	Traffic queueing, traffic policing, traffic shaping, Modular QoS CLI (MQC), Network-Based Application Recognition (NBAR), Multilink PPP (MLP) for QoS, header compression, AutoQoS, Resource Reservation Protocol (RSVP), and weighted random early detection (WRED).
• *Cisco IOS Security Command Reference*	Access control lists (ACLs); authentication, authorization, and accounting (AAA); firewalls; IP security and encryption; neighbor router authentication; network access security; network data encryption with router authentication; public key infrastructure (PKI); RADIUS; TACACS+; terminal access security; and traffic filters.
• *Cisco IOS Security Configuration Guide: Securing the Data Plane*	Access Control Lists (ACLs); Firewalls: Context-Based Access Control (CBAC) and Zone-Based Firewall; Cisco IOS Intrusion Prevention System (IPS); Flexible Packet Matching; Unicast Reverse Path Forwarding (uRPF); Threat Information Distribution Protocol (TIDP) and TMS.
• *Cisco IOS Security Configuration Guide: Securing the Control Plane*	Control Plane Policing, Neighborhood Router Authentication.
• *Cisco IOS Security Configuration Guide: Securing User Services*	AAA (includes 802.1x authentication and Network Admission Control [NAC]); Security Server Protocols (RADIUS and TACACS+); Secure Shell (SSH); Secure Access for Networking Devices (includes Autosecure and Role-Based CLI access); Lawful Intercept.
• *Cisco IOS Security Configuration Guide: Secure Connectivity*	Internet Key Exchange (IKE) for IPsec VPNs; IPsec Data Plane features; IPsec Management features; Public Key Infrastructure (PKI); Dynamic Multipoint VPN (DMVPN); Easy VPN; Cisco Group Encrypted Transport VPN (GETVPN); SSL VPN.

Table 1 Cisco IOS Configuration Guides and Command References (continued)

Configuration Guide and Command Reference Titles	Features/Protocols/Technologies
• *Cisco IOS Service Advertisement Framework Configuration Guide* • *Cisco IOS Service Advertisement Framework Command Reference*	Cisco Service Advertisement Framework.
• *Cisco IOS Service Selection Gateway Configuration Guide* • *Cisco IOS Service Selection Gateway Command Reference*	Subscriber authentication, service access, and accounting.
• *Cisco IOS Software Activation Configuration Guide* • *Cisco IOS Software Activation Command Reference*	An orchestrated collection of processes and components to activate Cisco IOS software feature sets by obtaining and validating Cisco software licenses.
• *Cisco IOS Software Modularity Installation and Configuration Guide* • *Cisco IOS Software Modularity Command Reference*	Installation and basic configuration of software modularity images, including installations on single and dual route processors, installation rollbacks, software modularity binding, software modularity processes, and patches.
• *Cisco IOS Terminal Services Configuration Guide* • *Cisco IOS Terminal Services Command Reference*	DEC, local-area transport (LAT), and X.25 packet assembler/disassembler (PAD).
• *Cisco IOS Virtual Switch Command Reference*	Virtual switch redundancy, high availability, and packet handling; converting between standalone and virtual switch modes; virtual switch link (VSL); Virtual Switch Link Protocol (VSLP). **Note** For information about virtual switch configuration, see the product-specific software configuration information for the Cisco Catalyst 6500 series switch or for the Metro Ethernet 6500 series switch.
• *Cisco IOS Voice Configuration Library* • *Cisco IOS Voice Command Reference*	Cisco IOS support for voice call control protocols, interoperability, physical and virtual interface management, and troubleshooting. The library includes documentation for IP telephony applications.
• *Cisco IOS VPDN Configuration Guide* • *Cisco IOS VPDN Command Reference*	Layer 2 Tunneling Protocol (L2TP) dial-out load balancing and redundancy; L2TP extended failover; L2TP security VPDN; multihop by Dialed Number Identification Service (DNIS); timer and retry enhancements for L2TP and Layer 2 Forwarding (L2F); RADIUS Attribute 82 (tunnel assignment ID); shell-based authentication of VPDN users; tunnel authentication via RADIUS on tunnel terminator.
• *Cisco IOS Wide-Area Networking Configuration Guide* • *Cisco IOS Wide-Area Networking Command Reference*	Frame Relay; Layer 2 Tunnel Protocol Version 3 (L2TPv3); L2VPN Pseudowire Redundancy; L2VPN Interworking; Layer 2 Local Switching; Link Access Procedure, Balanced (LAPB); and X.25.
• *Cisco IOS Wireless LAN Configuration Guide* • *Cisco IOS Wireless LAN Command Reference*	Broadcast key rotation, IEEE 802.11x support, IEEE 802.1x authenticator, IEEE 802.1x local authentication service for Extensible Authentication Protocol-Flexible Authentication via Secure Tunneling (EAP-FAST), Multiple Basic Service Set ID (BSSID), Wi-Fi Multimedia (WMM) required elements, and Wi-Fi Protected Access (WPA).

Table 2 lists documents and resources that supplement the Cisco IOS software configuration guides and command references.

Table 2 Cisco IOS Supplementary Documents and Resources

Document Title or Resource	Description
Cisco IOS Master Command List, All Releases	Alphabetical list of all the commands documented in all Cisco IOS releases.
Cisco IOS New, Modified, Removed, and Replaced Commands	List of all the new, modified, removed, and replaced commands for a Cisco IOS release.
Cisco IOS System Message Guide	List of Cisco IOS system messages and descriptions. System messages may indicate problems with your system, may be informational only, or may help diagnose problems with communications lines, internal hardware, or system software.
Cisco IOS Debug Command Reference	Alphabetical list of **debug** commands including brief descriptions of use, command syntax, and usage guidelines.
Release Notes and Caveats	Information about new and changed features, system requirements, and other useful information about specific software releases; information about defects in specific Cisco IOS software releases.
MIBs	Files used for network monitoring. To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator.
RFCs	Standards documents maintained by the Internet Engineering Task Force (IETF) that Cisco IOS documentation references where applicable. The full text of referenced RFCs may be obtained at the following URL: http://www.rfc-editor.org/

Additional Resources and Documentation Feedback

What's New in Cisco Product Documentation is released monthly and describes all new and revised Cisco technical documentation. The *What's New in Cisco Product Documentation* publication also provides information about obtaining the following resources:

- Technical documentation
- Cisco product security overview
- Product alerts and field notices
- Technical assistance

Cisco IOS technical documentation includes embedded feedback forms where you can rate documents and provide suggestions for improvement. Your feedback helps us improve our documentation.

Using the Command-Line Interface in Cisco IOS Software

Last Updated: October 14, 2009

This document provides basic information about the command-line interface (CLI) in Cisco IOS software and how you can use some of the CLI features. This document contains the following sections:

For more information about using the CLI, see the "Using the Cisco IOS Command-Line Interface" section of the *Cisco IOS Configuration Fundamentals Configuration Guide*.

For information about the software documentation set, see the "About Cisco IOS Software Documentation" document.

Initially Configuring a Device

Initially configuring a device varies by platform. For information about performing an initial configuration, see the hardware installation documentation that is provided with the original packaging of the product or go to the Product/Technologies Support area of Cisco.com at http://www.cisco.com/go/techdocs.

After you have performed the initial configuration and connected the device to your network, you can configure the device by using the console port or a remote access method, such as Telnet or Secure Shell (SSH), to access the CLI or by using the configuration method provided on the device, such as Security Device Manager.

Changing the Default Settings for a Console or AUX Port

There are only two changes that you can make to a console port and an AUX port:

- Change the port speed with the **config-register 0x** command. Changing the port speed is not recommended. The well-known default speed is 9600.
- Change the behavior of the port; for example, by adding a password or changing the timeout value.

Note The AUX port on the Route Processor (RP) installed in a Cisco ASR 1000 series router does not serve any useful customer purpose and should be accessed only under the advisement of a customer support representative.

Using the CLI

This section describes the following topics:

Understanding Command Modes

The CLI command mode structure is hierarchical, and each mode supports a set of specific commands. This section describes the most common of the many modes that exist.

Table 1 lists common command modes with associated CLI prompts, access and exit methods, and a brief description of how each mode is used.

Table 1 CLI Command Modes

Command Mode	Access Method	Prompt	Exit Method	Mode Usage
User EXEC	Log in.	`Router>`	Issue the **logout** or **exit** command.	• Change terminal settings. • Perform basic tests. • Display device status.
Privileged EXEC	From user EXEC mode, issue the **enable** command.	`Router#`	Issue the **disable** command or the **exit** command to return to user EXEC mode.	• Issue **show** and **debug** commands. • Copy images to the device. • Reload the device. • Manage device configuration files. • Manage device file systems.
Global configuration	From privileged EXEC mode, issue the **configure terminal** command.	`Router(config)#`	Issue the **exit** command or the **end** command to return to privileged EXEC mode.	Configure the device.
Interface configuration	From global configuration mode, issue the **interface** command.	`Router(config-if)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual interfaces.
Line configuration	From global configuration mode, issue the **line vty** or **line console** command.	`Router(config-line)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual terminal lines.

Table 1 CLI Command Modes (continued)

Command Mode	Access Method	Prompt	Exit Method	Mode Usage
ROM monitor	From privileged EXEC mode, issue the **reload** command. Press the **Break** key during the first 60 seconds while the system is booting.	`rommon # >` The # symbol represents the line number and increments at each prompt.	Issue the **continue** command.	• Run as the default operating mode when a valid image cannot be loaded. • Access the fall-back procedure for loading an image when the device lacks a valid image and cannot be booted. • Perform password recovery when a Ctrl-Break sequence is issued within 60 seconds of a power-on or reload event.
Diagnostic (available only on Cisco ASR 1000 series routers)	The router boots or enters diagnostic mode in the following scenarios. When a Cisco IOS process or processes fail, in most scenarios the router will reload. • A user-configured access policy was configured using the **transport-map** command, which directed the user into diagnostic mode. • The router was accessed using an RP auxiliary port. • A break signal (**Ctrl-C**, **Ctrl-Shift-6**, or the **send break** command) was entered, and the router was configured to enter diagnostic mode when the break signal was received.	`Router(diag)#`	If a Cisco IOS process failure is the reason for entering diagnostic mode, the failure must be resolved and the router must be rebooted to exit diagnostic mode. If the router is in diagnostic mode because of a transport-map configuration, access the router through another port or use a method that is configured to connect to the Cisco IOS CLI. If the RP auxiliary port was used to access the router, use another port for access. Accessing the router through the auxiliary port is not useful for customer purposes.	• Inspect various states on the router, including the Cisco IOS state. • Replace or roll back the configuration. • Provide methods of restarting the Cisco IOS software or other processes. • Reboot hardware (such as the entire router, an RP, an ESP, a SIP, a SPA) or other hardware components. • Transfer files into or off of the router using remote access methods such as FTP, TFTP, and SCP.

EXEC commands are not saved when the software reboots. Commands that you issue in a configuration mode can be saved to the startup configuration. If you save the running configuration to the startup configuration, these commands will execute when the software is rebooted. Global configuration mode is the highest level of configuration mode. From global configuration mode, you can enter a variety of other configuration modes, including protocol-specific modes.

ROM monitor mode is a separate mode that is used when the software cannot load properly. If a valid software image is not found when the software boots or if the configuration file is corrupted at startup, the software might enter ROM monitor mode. Use the question symbol (?) to view the commands that you can use while the device is in ROM monitor mode.

```
rommon 1 > ?
alias               set and display aliases command
boot                boot up an external process
confreg             configuration register utility
cont                continue executing a downloaded image
context             display the context of a loaded image
cookie              display contents of cookie PROM in hex
.
.
.
rommon 2 >
```

The following example shows how the command prompt changes to indicate a different command mode:

```
Router> enable
Router# configure terminal
Router(config)# interface ethernet 1/1
Router(config-if)# ethernet
Router(config-line)# exit
Router(config)# end
Router#
```

Note A keyboard alternative to the **end** command is Ctrl-Z.

Using the Interactive Help Feature

The CLI includes an interactive Help feature. Table 2 describes the purpose of the CLI interactive Help commands.

Table 2 CLI Interactive Help Commands

Command	Purpose
help	Provides a brief description of the Help feature in any command mode.
?	Lists all commands available for a particular command mode.
partial command<**?**>	Provides a list of commands that begin with the character string (no space between the command and the question mark).
partial command<**Tab**>	Completes a partial command name (no space between the command and <Tab>).
command **?**	Lists the keywords, arguments, or both associated with the command (space between the command and the question mark).
command keyword **?**	Lists the arguments that are associated with the keyword (space between the keyword and the question mark).

The following examples show how to use the help commands:

help

```
Router> help

Help may be requested at any point in a command by entering a question mark '?'. If nothing
matches, the help list will be empty and you must backup until entering a '?' shows the
available options.

Two styles of help are provided:

1. Full help is available when you are ready to enter a command argument (e.g. 'show ?')
and describes each possible argument.

2. Partial help is provided when an abbreviated argument is entered and you want to know
what arguments match the input (e.g. 'show pr?'.)
```

?

```
Router# ?
Exec commands:
  access-enable        Create a temporary access-List entry
  access-profile       Apply user-profile to interface
  access-template      Create a temporary access-List entry
  alps                 ALPS exec commands
  archive              manage archive files
<snip>
```

partial command?

```
Router(config)# zo?
zone  zone-pair
```

partial command<Tab>

```
Router(config)# we<Tab> webvpn
```

command ?

```
Router(config-if)# pppoe ?
  enable        Enable pppoe
  max-sessions  Maximum PPPOE sessions
```

command keyword ?

```
Router(config-if)# pppoe enable ?
  group  attach a BBA group
  <cr>
```

Understanding Command Syntax

Command syntax is the format in which a command should be entered in the CLI. Commands include the name of the command, keywords, and arguments. Keywords are alphanumeric strings that are used literally. Arguments are placeholders for values that a user must supply. Keywords and arguments may be required or optional.

Specific conventions convey information about syntax and command elements. Table 3 describes these conventions.

Table 3 CLI Syntax Conventions

Symbol/Text	Function	Notes
< > (angle brackets)	Indicate that the option is an argument.	Sometimes arguments are displayed without angle brackets.
A.B.C.D.	Indicates that you must enter a dotted decimal IP address.	Angle brackets (< >) are not always used to indicate that an IP address is an argument.
WORD (all capital letters)	Indicates that you must enter one word.	Angle brackets (< >) are not always used to indicate that a WORD is an argument.
LINE (all capital letters)	Indicates that you must enter more than one word.	Angle brackets (< >) are not always used to indicate that a LINE is an argument.
<cr> (carriage return)	Indicates the end of the list of available keywords and arguments, and also indicates when keywords and arguments are optional. When <cr> is the only option, you have reached the end of the branch or the end of the command if the command has only one branch.	—

The following examples show syntax conventions:

```
Router(config)# ethernet cfm domain ?
  WORD  domain name
Router(config)# ethernet cfm domain dname ?
  level
Router(config)# ethernet cfm domain dname level ?
  <0-7>  maintenance level number
Router(config)# ethernet cfm domain dname level 7 ?
  <cr>

Router(config)# snmp-server file-transfer access-group 10 ?
  protocol  protocol options
  <cr>

Router(config)# logging host ?
  Hostname or A.B.C.D  IP address of the syslog server
  ipv6                 Configure IPv6 syslog server
```

Understanding Enable and Enable Secret Passwords

Some privileged EXEC commands are used for actions that impact the system, and it is recommended that you set a password for these commands to prevent unauthorized use. Two types of passwords, enable (not encrypted) and enable secret (encrypted), can be set. The following commands set these passwords and are issued in global configuration mode:

- **enable** *password*
- **enable secret** *password*

Using an enable secret password is recommended because it is encrypted and more secure than the enable password. When you use an enable secret password, text is encrypted (unreadable) before it is written to the config.text file. When you use an enable password, the text is written as entered (readable) to the config.text file.

Each type of password is case sensitive, can contain from 1 to 25 uppercase and lowercase alphanumeric characters, and can start with a numeral. Spaces are also valid password characters; for example, "two words" is a valid password. Leading spaces are ignored, but trailing spaces are recognized.

Note Both password commands have numeric keywords that are single integer values. If you choose a numeral for the first character of your password followed by a space, the system will read the number as if it were the numeric keyword and not as part of your password.

When both passwords are set, the enable secret password takes precedence over the enable password.

To remove a password, use the **no** form of the commands: **no enable** *password* or **no enable secret** *password*.

For more information about password recovery procedures for Cisco products, see http://www.cisco.com/en/US/products/sw/iosswrel/ps1831/products_tech_note09186a00801746e6.shtml.

Using the Command History Feature

The command history feature saves, in a command history buffer, the commands that you enter during a session. The default number of saved commands is 10, but the number is configurable within the range of 0 to 256. This command history feature is particularly useful for recalling long or complex commands.

To change the number of commands saved in the history buffer for a terminal session, issue the **terminal history size** command:

```
Router# terminal history size num
```

A command history buffer is also available in line configuration mode with the same default and configuration options. To set the command history buffer size for a terminal session in line configuration mode, issue the **history** command:

```
Router(config-line)# history [size num]
```

To recall commands from the history buffer, use the following methods:

- Press Ctrl-P or the Up Arrow key—Recalls commands beginning with the most recent command. Repeat the key sequence to recall successively older commands.
- Press Ctrl-N or the Down Arrow key—Recalls the most recent commands in the history buffer after they have been recalled using Ctrl-P or the Up Arrow key. Repeat the key sequence to recall successively more recent commands.

  Note The arrow keys function only on ANSI-compatible terminals such as the VT100.

- Issue the **show history** command in user EXEC or privileged EXEC mode—Lists the most recent commands that you entered. The number of commands that are displayed is determined by the setting of the **terminal history size** and **history** commands.

The command history feature is enabled by default. To disable this feature for a terminal session, issue the **terminal no history** command in user EXEC or privileged EXEC mode or the **no history** command in line configuration mode.

Abbreviating Commands

Typing a complete command name is not always required for the command to execute. The CLI recognizes an abbreviated command when the abbreviation contains enough characters to uniquely identify the command. For example, the **show version** command can be abbreviated as **sh ver**. It cannot be abbreviated as **s ver** because **s** could mean **show**, **set**, or **systat**. The **sh v** abbreviation also is not valid because the **show** command has **vrrp** as a keyword in addition to **version**. (Command and keyword examples are from Cisco IOS Release 12.4(13)T.)

Using Aliases for CLI Commands

To save time and the repetition of entering the same command multiple times, you can use a command alias. An alias can be configured to do anything that can be done at the command line, but an alias cannot move between modes, type in passwords, or perform any interactive functions.

Table 4 shows the default command aliases.

Table 4 Default Command Aliases

Command Alias	Original Command
h	help
lo	logout
p	ping
s	show
u or **un**	undebug
w	where

To create a command alias, issue the **alias** command in global configuration mode. The syntax of the command is **alias** *mode command-alias original-command*. Following are some examples:

- Router(config)# **alias exec prt partition**—privileged EXEC mode
- Router(config)# **alias configure sb source-bridge**—global configuration mode
- Router(config)# **alias interface rl rate-limit**—interface configuration mode

To view both default and user-created aliases, issue the **show alias** command.

For more information about the **alias** command, see http://www.cisco.com/en/US/docs/ios/fundamentals/command/reference/cf_a1.html.

Using the no and default Forms of Commands

Most configuration commands have a **no** form that is used to reset a command to its default value or disable a feature or function. For example, the **ip routing** command is enabled by default. To disable this command, you would issue the **no ip routing** command. To re-enable IP routing, you would issue the **ip routing** command.

Configuration commands may also have a **default** form, which returns the command settings to their default values. For commands that are disabled by default, using the **default** form has the same effect as using the **no** form of the command. For commands that are enabled by default and have default settings, the **default** form enables the command and returns the settings to their default values.

The **no** form is documented in the command pages of command references. The **default** form is generally documented in the command pages only when the **default** form performs a different function than the plain and **no** forms of the command. To see what **default** commands are available on your system, enter **default ?** in the appropriate command mode.

Using the debug Command

A **debug** command produces extensive output that helps you troubleshoot problems in your network. These commands are available for many features and functions within Cisco IOS software. Some **debug** commands are **debug all**, **debug aaa accounting**, and **debug mpls packets**. To use **debug** commands during a Telnet session with a device, you must first enter the **terminal monitor** command. To turn off debugging completely, you must enter the **undebug all** command.

For more information about **debug** commands, see the *Cisco IOS Debug Command Reference* at http://www.cisco.com/en/US/docs/ios/debug/command/reference/db_book.html.

Caution Debugging is a high priority and high CPU utilization process that can render your device unusable. Use **debug** commands only to troubleshoot specific problems. The best times to run debugging are during periods of low network traffic and when few users are interacting with the network. Debugging during these periods decreases the likelihood that the **debug** command processing overhead will affect network performance or user access or response times.

Filtering Output Using Output Modifiers

Many commands produce lengthy output that may use several screens to display. Using output modifiers, you can filter this output to show only the information that you want to see.

The following three output modifiers are available:

- **begin** *regular-expression*—Displays the first line in which a match of the regular expression is found and all lines that follow.
- **include** *regular-expression*—Displays all lines in which a match of the regular expression is found.
- **exclude** *regular-expression*—Displays all lines except those in which a match of the regular expression is found.

To use one of these output modifiers, type the command followed by the pipe symbol (|), the modifier, and the regular expression that you want to search for or filter. A regular expression is a case-sensitive alphanumeric pattern. It can be a single character or number, a phrase, or a more complex string.

The following example illustrates how to filter output of the **show interface** command to display only lines that include the expression "protocol."

```
Router# show interface | include protocol

FastEthernet0/0 is up, line protocol is up
Serial4/0 is up, line protocol is up
Serial4/1 is up, line protocol is up
Serial4/2 is administratively down, line protocol is down
Serial4/3 is administratively down, line protocol is down
```

Understanding CLI Error Messages

You may encounter some error messages while using the CLI. Table 5 shows the common CLI error messages.

Table 5 Common CLI Error Messages

Error Message	Meaning	How to Get Help
% Ambiguous command: "show con"	You did not enter enough characters for the command to be recognized.	Reenter the command followed by a space and a question mark (?). The keywords that you are allowed to enter for the command appear.
% Incomplete command.	You did not enter all the keywords or values required by the command.	Reenter the command followed by a space and a question mark (?). The keywords that you are allowed to enter for the command appear.
% Invalid input detected at "^" marker.	You entered the command incorrectly. The caret (^) marks the point of the error.	Enter a question mark (?) to display all the commands that are available in this command mode. The keywords that you are allowed to enter for the command appear.

For more system error messages, see the following document:

- *Cisco IOS Release 12.4T System Message Guide*

Saving Changes to a Configuration

To save changes that you made to the configuration of a device, you must issue the **copy running-config startup-config** command or the **copy system:running-config nvram:startup-config** command. When you issue these commands, the configuration changes that you made are saved to the startup configuration and saved when the software reloads or power to the device is turned off or interrupted. The following example shows the syntax of the **copy running-config startup-config** command:

```
Router# copy running-config startup-config
Destination filename [startup-config]?
```

You press Enter to accept the startup-config filename (the default), or type a new filename and then press Enter to accept that name. The following output is displayed indicating that the configuration was saved.

```
Building configuration...
[OK]
Router#
```

On most platforms, the configuration is saved to NVRAM. On platforms with a Class A flash file system, the configuration is saved to the location specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM.

Additional Information

- "Using the Cisco IOS Command-Line Interface" section of the *Cisco IOS Configuration Fundamentals Configuration Guide*

  http://www.cisco.com/en/US/docs/ios/fundamentals/configuration/guide/cf_cli-basics.html
- Cisco Product/Technology Support

  http://www.cisco.com/go/techdocs
- Support area on Cisco.com (also search for documentation by task or product)

  http://www.cisco.com/en/US/support/index.html
- Software Download Center (downloads; tools; licensing, registration, advisory, and general information) (requires Cisco.com user ID and password)

  http://www.cisco.com/kobayashi/sw-center/
- Error Message Decoder, a tool to help you research and resolve error messages for Cisco IOS software

  http://www.cisco.com/pcgi-bin/Support/Errordecoder/index.cgi
- Command Lookup Tool, a tool to help you find detailed descriptions of Cisco IOS commands (requires Cisco.com user ID and password)

  http://tools.cisco.com/Support/CLILookup
- Output Interpreter, a troubleshooting tool that analyzes command output of supported **show** commands

  https://www.cisco.com/pcgi-bin/Support/OutputInterpreter/home.pl

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Cisco IOS IP SLAs Features Roadmap

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This feature roadmap lists the Cisco IOS features documented in the Cisco IOS IP SLAs Configuration Guide and maps them to the documents in which they appear. The roadmap is organized so that you can select your release train and see the features in that release. Find the feature name you are searching for and click on the URL in the "Where Documented" column to access the document containing that feature.

Configuration Guide and Command Reference Documentation

Cisco IOS IP SLAs configuration guide and command reference documentation can be found at the following locations:

- Cisco IOS IP SLAs Configuration Guide, Release 12.2SR

  http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/12_2sr/sla_12_2sr_book.html
- Cisco IOS IP SLAs Configuration Guide, Release 12.2SX

  http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/12_2sx/sla_12_2sx_book.html
- Cisco IOS IP SLAs Configuration Guide, Release 12.4T

  http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/12_4t/sla_12_4t_book.html
- Cisco IOS IP SLAs Configuration Guide, Release 12.4

  http://www.cisco.com/en/US/docs/ios/12_4/ip_sla/configuration/guide/hsla_c.html
- Cisco IOS IP SLAs Command Reference

  http://www.cisco.com/en/US/docs/ios/ipsla/command/reference/sla_book.html

  For information about all Cisco IOS commands, use the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or the *Cisco IOS Master Command List, All Releases*, at http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html.

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Feature and Release Support

Table 1 lists IP SLAs feature support for the following Cisco IOS software release trains:

- Cisco IOS Release 12.2SR
- Cisco IOS Release 12.2SX
- Cisco IOS Release 12.4T

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1 lists the features in alphabetical order within the release.

Table 1 Supported Cisco IOS IP SLAs Features

Release	Feature Name	Feature Description	Where Documented
Cisco IOS Release 12.2SR			
12.2SR	Overview	Overview of the Cisco IOS IP SLAs technology.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_overview.html
12.2SR	DHCP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dhcp.html
12.2SR	DNS Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dns.html
12.2SR	Ethernet Operation	The Cisco IOS IP 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_metro_ethernet.html
12.2SR	FTP Operation	The Cisco IOS IP 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_ftp.html
12.2SR	HTTP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_http.html
12.2SR	ICMP Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_echo.html

Table 1 Supported Cisco IOS IP SLAs Features (continued)

Release	Feature Name	Feature Description	Where Documented
12.2SR	ICMP Path Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathecho.html
12.2SR	ICMP Path Jitter Operation	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathjitter.html
12.2SR	IP SLAs for IPv6	The Cisco IOS IP SLAs UDP jitter, UDP echo, ICMP echo, and TCP connect operations are supported for IPv6.	http://www.cisco.com/en/US/docs/ios/ipv6/configuration/guide/ip6-mng_apps.html
12.2SR	LSP Health Monitor	The Cisco IOS IP SLAs label switched path (LSP) Health Monitor feature provides the capability to proactively monitor Layer 3 Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_lsp_mon_autodisc.html
12.2SR	LSP Health Monitor with LSP Discovery	This enhancement to the IP SLAs - LSP Health Monitor feature provides automated end-to-end verification in the control plane and data plane for all LSPs between the participating Provider Edge (PE) routers.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_lsp_mon_autodisc.html
12.2SR	Multioperation Scheduler	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for Cisco IOS IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_multi_scheduler.html
12.2SR	Proactive Threshold Monitoring	Cisco IOS IP SLAs proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_threshold_mon.html
12.2SR	TCP Connect Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_tcp.html
12.2SR	UDP Echo Operation	The Cisco IOS IP SLAs User Datagram Protocol (UDP) echo operation allows you to measure end-to-end network response time between a Cisco device and other devices using IP	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_echo.html
12.2SR	UDP Jitter Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter.html

Table 1 Supported Cisco IOS IP SLAs Features (continued)

Release	Feature Name	Feature Description	Where Documented
12.2SR	UDP VoIP Operation	The Cisco IOS IP SLAs Voice over IP (VoIP) User Datagram Protocol (UDP)UDP jitter operation allows you to proactively monitor VoIP quality levels in your network, allowing you to guarantee VoIP quality levels to your users.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter_voip.html
12.2SR	VCCV Operation	The Cisco IOS IP SLAs VCCV operation supports Virtual Circuit Connectivity Verification (VCCV) for Pseudo-Wire Emulation Edge-to-Edge (PWE3) services across MPLS networks.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_lsp_mon_autodisc.html
Cisco IOS Release 12.2SX			
12.2SX	Overview	Overview of the Cisco IOS IP SLAs technology.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_overview.html
12.2SX	DHCP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dhcp.html
12.2SX	DNS Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dns.html
12.2SX	FTP Operation	The Cisco IOS IP 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_ftp.html
12.2SX	HTTP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_http.html
12.2SX	ICMP Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_echo.html
12.2SX	ICMP Path Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathecho.html
12.2SX	ICMP Path Jitter Operation	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathjitter.html

Table 1 Supported Cisco IOS IP SLAs Features (continued)

Release	Feature Name	Feature Description	Where Documented
12.2SX	LSP Health Monitor	The Cisco IOS IP SLAs label switched path (LSP) Health Monitor feature provides the capability to proactively monitor Layer 3 Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_lsp_mon_autodisc.html
12.2SX	Multioperation Scheduler	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for Cisco IOS IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_multi_scheduler.html
12.2SX	Proactive Threshold Monitoring	Cisco IOS IP SLAs proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_threshold_mon.html
12.2SX	TCP Connect Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_tcp.html
12.2SX	UDP Echo Operation	The Cisco IOS IP SLAs User Datagram Protocol (UDP) echo operation allows you to measure end-to-end network response time between a Cisco device and other devices using IP	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_echo.html
12.2SX	UDP Jitter Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter.html
12.2SX	UDP VoIP Operation	The Cisco IOS IP SLAs Voice over IP (VoIP) User Datagram Protocol (UDP)UDP jitter operation allows you to proactively monitor VoIP quality levels in your network, allowing you to guarantee VoIP quality levels to your users.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter_voip.html
Cisco IOS Release 12.4T			
12.4T	Overview	Overview of the Cisco IOS IP SLAs technology.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_overview.html
12.4T	DHCP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dhcp.html
12.4T	DLSw+ Operation	The Cisco IOS IP SLAs Data Link Switching Plus (DLSw+) operation allows you to schedule and measure the DLSw+ protocol stack and network response time between DLSw+ peers.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dlsw.html

Table 1 Supported Cisco IOS IP SLAs Features (continued)

Release	Feature Name	Feature Description	Where Documented
12.4T	DNS Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_dns.html
12.4T	Ethernet Operation	The Cisco IOS IP 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_metro_ethernet.html
12.4T	FTP Operation	The Cisco IOS IP 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_ftp.html
12.4T	HTTP Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_http.html
12.4T	ICMP Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_echo.html
12.4T	ICMP Jitter Operation	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) Jitter operation allows you to generate a stream of ICMP packets between a Cisco IOS device (source) and any other IP device (destination) to gather network performance-related statistics.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_jitter.html
12.4T	ICMP Path Echo Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathecho.html
12.4T	ICMP Path Jitter Operation	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_icmp_pathjitter.html
12.4T	IP SLAs for IPv6	The Cisco IOS IP SLAs UDP jitter, UDP echo, ICMP echo, and TCP connect operations are supported for IPv6.	http://www.cisco.com/en/US/docs/ios/ipv6/configuration/guide/ip6-mng_apps.html
12.4T	LSP Health Monitor	The Cisco IOS IP SLAs label switched path (LSP) Health Monitor feature provides the capability to proactively monitor Layer 3 Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs).	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_lsp_mon_autodisc.html

Table 1 Supported Cisco IOS IP SLAs Features (continued)

Release	Feature Name	Feature Description	Where Documented
12.4T	Multioperation Scheduler	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for Cisco IOS IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_multi_scheduler.html
12.4T	Proactive Threshold Monitoring	Cisco IOS IP SLAs proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_threshold_mon.html
12.4T	RTP Based VoIP Operation	The IP SLAs Real-Time Transport Protocol (RTP)-based Voice over IP (VoIP) operation allows you to set up and schedule a test call and use Voice gateway digital signal processors (DSPs) to gather network performance-related statistics for the call.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_rtp_voip.html
12.4T	TCP Connect Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_tcp.html
12.4T	UDP Echo Operation	The Cisco IOS IP SLAs User Datagram Protocol (UDP) echo operation allows you to measure end-to-end network response time between a Cisco device and other devices using IP	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_echo.html
12.4T	UDP Jitter Operation	The Cisco IOS 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.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter.html
12.4T	UDP VoIP Operation	The Cisco IOS IP SLAs Voice over IP (VoIP) User Datagram Protocol (UDP)UDP jitter operation allows you to proactively monitor VoIP quality levels in your network, allowing you to guarantee VoIP quality levels to your users.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_udp_jitter_voip.html
12.4T	VoIP Call Setup (Post Dial Delay) Monitoring	The Cisco IOS IP SLAs Voice over IP (VoIP) call setup operation allows you to measure network response time for setting up a VoIP call.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_call_setup.html
12.4T	VoIP Gatekeeper Delay Monitoring	The Cisco IOS IP SLAs Voice over IP (VoIP) gatekeeper registration delay operation allows you to measure the average, median, or aggregated network response time of registration attempts from a VoIP gateway to a VoIP gatekeeper device.	http://www.cisco.com/en/US/docs/ios/ipsla/configuration/guide/sla_gatekpr_voip.html

Cisco IOS IP SLAs Overview

First Published: August 14, 2006
Last Updated: October 14, 2008

This module describes Cisco IOS IP Service Level Agreements (SLAs). Cisco IOS IP SLAs is a core part of the Cisco IOS software portfolio, which 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. Cisco IOS IP SLAs uses active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner—for measuring network performance. Using Cisco IOS 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. Cisco IOS IP SLAs can perform network assessments, verify quality of service (QoS), ease the deployment of new services, and assist administrators with network troubleshooting. Cisco IOS IP SLAs can be accessed using the Cisco IOS command-line interface (CLI) 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.

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

Contents

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Prerequisites for Cisco IOS IP SLAs

Knowledge of general networking protocols and your specific network design is assumed. Familiarity with network management applications is useful.

Information About Cisco IOS IP SLAs

To implement general configuration and scheduling of Cisco IOS IP SLAs, you should understand the following concepts:

Cisco IOS IP SLAs Technology Overview

Cisco IOS IP SLAs uses active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner—for measuring network performance. Cisco IOS 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. Cisco IOS IP SLAs performs active monitoring by generating and analyzing traffic to measure performance either between Cisco IOS devices or from a Cisco IOS device to a remote IP device such as a network application server. Measurement statistics provided by the various Cisco IOS IP SLAs operations can be used for troubleshooting, for problem analysis, and for designing network topologies.

Using Cisco IOS 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. Cisco IOS IP SLAs uses unique service level assurance metrics and methodology to provide highly accurate, precise service level assurance measurements.

Depending on the specific Cisco IOS 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, Cisco IOS 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 Cisco IOS 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 Cisco IOS 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. More details about network management products that use Cisco IOS IP SLAs can be found at the following URL:

http://www.cisco.com/go/ipsla

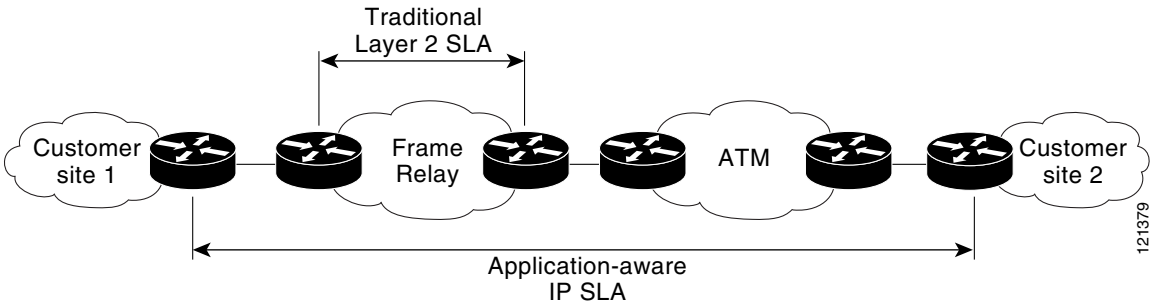
SNMP notifications based on the data gathered by a Cisco IOS IP SLAs operation allow the router to receive alerts when performance drops below a specified level and when problems are corrected. Cisco IOS IP SLAs uses the Cisco RTTMON MIB for interaction between external Network Management System (NMS) applications and the Cisco IOS IP SLAs operations running on the Cisco devices. For a complete description of the object variables referenced by the Cisco IOS 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. Figure 1 shows how Cisco IOS 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 Cisco IOS IP SLAs



Cisco IOS 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 Cisco IOS IP SLAs easier and cheaper to implement than the physical probes often required with traditional service level agreements.
- Application-aware monitoring—Cisco IOS 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—Cisco IOS IP SLAs support exists in Cisco networking devices ranging from low-end to high-end routers and switches. This wide range of deployment gives Cisco IOS 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 Cisco IOS IP SLAs

- Cisco IOS 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

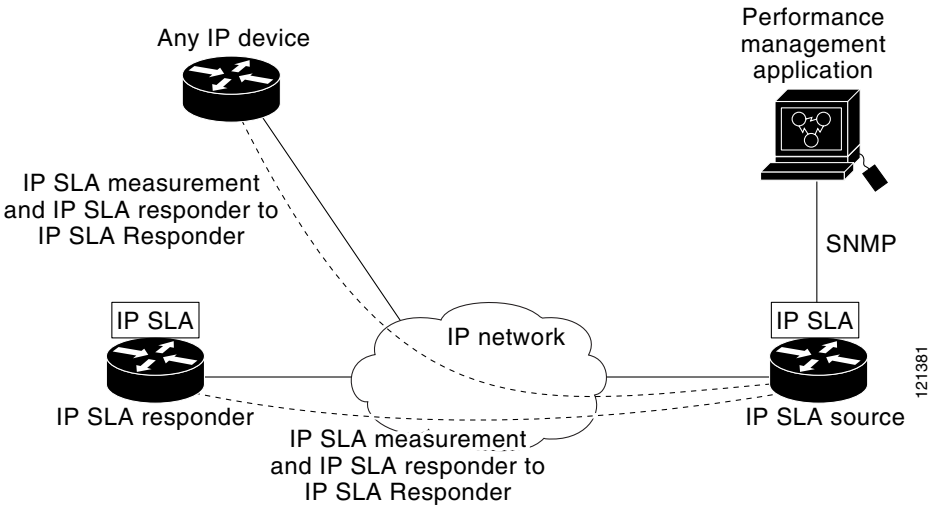
  - Provides consistent, reliable measurement that immediately identifies problems and saves troubleshooting time.
- Voice over IP (VoIP) performance monitoring
- Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) performance monitoring and network verification

Network Performance Measurement Using Cisco IOS IP SLAs

Cisco IOS IP SLAs is a core part of the Cisco IOS software portfolio. Using Cisco IOS 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.

Cisco IOS IP SLAs uses generated traffic to measure network performance between two networking devices such as routers. Figure 2 shows how Cisco IOS IP SLAs starts when the Cisco IOS IP SLAs device sends a generated packet to the destination device. After the destination device receives the packet, and depending on the type of Cisco IOS IP SLAs operation, the device will respond with time-stamp information for the source to make the calculation on performance metrics. A Cisco IOS 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 Cisco IOS IP SLAs Operations



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

1. Enable the Cisco IOS IP SLAs Responder, if appropriate.
2. Configure the required Cisco IOS IP SLAs operation type.
3. Configure any options available for the specified Cisco IOS 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 IOS CLI or an NMS system with SNMP.

Conceptual information about the Cisco IOS IP SLAs Responder and Cisco IOS IP SLAs control protocol, the various Cisco IOS IP SLAs operation types, thresholding options, and scheduling options are contained in this document. To locate the documentation that includes configuration details and information about the options for each Cisco IOS IP SLAs operation type, see the *Cisco IOS IP SLAs Features Roadmap*.

Cisco IOS IP SLAs Operation Types

The various types of Cisco IOS 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

To locate the documentation that includes configuration details and information about the options for each Cisco IOS IP SLAs operation type, see the *Cisco IOS IP SLAs Features Roadmap*.

Cisco IOS IP SLAs Responder and IP SLAs Control Protocol

The Cisco IOS IP SLAs Responder is a component embedded in the destination Cisco routing device that allows the system to anticipate and respond to Cisco IOS IP SLAs request packets. The Cisco IOS 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 Cisco IOS IP SLAs Control Protocol is used by the Cisco IOS IP SLAs Responder providing a mechanism through which the responder can be notified on which port it should listen and respond. Only a Cisco IOS device can be a source for a destination IP SLAs Responder.

Figure 2 shows where the Cisco IOS IP SLAs Responder fits in relation to the IP network. The Cisco IOS IP SLAs Responder listens on a specific port for control protocol messages sent by a Cisco IOS 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 Cisco IOS IP SLAs packet, or when the specified time expires. For added security, MD5 authentication for control messages is available.

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

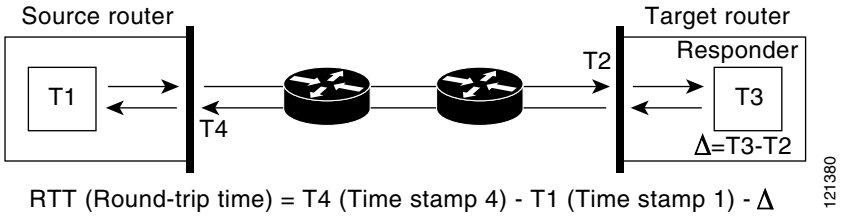
Response Time Computation for Cisco IOS IP SLAs

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. Cisco IOS IP SLAs minimizes these processing delays on the source router as well as on the target router (if Cisco IOS IP SLAs Responder is being used), in order to determine true round-trip times. Cisco IOS IP SLAs test packets use time stamping to minimize the processing delays.

When enabled, the Cisco IOS 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 a Cisco IOS IP SLAs test shows an accurate response time due to the time stamping on the responder.

Figure 3 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 Cisco IOS 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 Cisco IOS IP SLAs Responder Time Stamping



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.

Cisco IOS IP SLAs Operation Scheduling

After a Cisco IOS 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 Cisco IOS IP SLAs operation or a group of operations at one time.

Multioperations scheduling allows you to schedule multiple Cisco IOS IP SLAs operations using a single command through the Cisco IOS 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. 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" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Cisco IOS 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. Cisco IOS 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, a Cisco IOS IP SLAs threshold violation can trigger another Cisco IOS 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 Cisco IOS IP SLAs operations, see the "IP SLAs—Proactive Threshold Monitoring of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

MPLS VPN Awareness

The Cisco IOS 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.

Where to Go Next

For configuration details and information about IP SLAs operation types and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to Cisco IOS IP SLAs.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
Cisco IOS IP SLAs commands	*Cisco IOS 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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

IP SLAs—Analyzing IP Service Levels Using the UDP Jitter Operation

First Published: August 14, 2006
Last Updated: March 10, 2009

This document describes how to use the Cisco IOS IP 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.

Cisco IOS IP SLAs is an embedded feature set in Cisco IOS software that allows you to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce occurrences of network congestion or outages. IP SLAs uses active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner—for measuring network performance. The accuracy of measured data is enhanced by enabling the IP SLAs Responder, available in Cisco routers, on the destination device. This module also demonstrates how the data gathered using the UDP jitter operation can be displayed and analyzed using the Cisco IOS command-line interface (CLI).

Note A VoIP-specific implementation of the UDP jitter operation is available to measure performance by simulating specific voice codecs and returned voice quality scores. For more information, see the "IP SLAs—Analyzing VoIP Service Levels Using the UDP Jitter Operation" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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 for the IP SLAs UDP Jitter Operation" section on page 13.

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

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Contents

Information About the IP SLAs UDP Jitter Operation

To perform the tasks required to verify service levels using the IP SLAs UDP jitter operation, you should understand the following concept:

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.

How to Configure the IP SLAs UDP Jitter Operation

This section contains the following procedures:

- Configuring the IP SLAs Responder on the Destination Device, page 3 (required)
- Configuring and Scheduling a UDP Jitter Operation on the Source Device, page 3 (required)

Configuring the IP SLAs Responder on the Destination Device

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.

Perform this task to enable the IP SLAs Responder.

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:** `Router(config)# ip sla responder`	Enables the IP SLAs Responder.
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 one of the following tasks in this section, depending on whether you want to configure a basic UDP jitter operation or configure a UDP jitter operation with additional characteristics:

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.

A single UDP jitter operation consists of *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 packets (*N*), each with an RTP payload size of 32 bytes (*S*), are generated every 20 ms (*T*), and the operation is repeated every 60 seconds (*F*). Each of these parameters are user-configurable, as shown in Table 1.

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
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

Prerequisites

Use of the UDP jitter operation requires that the IP SLAs Responder be enabled on the target Cisco device. To enable the Responder, perform the task in the "Configuring the IP SLAs Responder on the Destination Device" section on page 3.

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 Network Manageent 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.

Restrictions

The 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.

Configuring and Scheduling a Basic UDP Jitter Operation on the Source Device

Perform this task to configure and schedule a basic UDP jitter operation.

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. After entering this command, the command-line interface (CLI) enters IP SLA jitter configuration mode to allow you to specify optional characteristics for the operation.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**exit** **Example:** `Router(config-ip-sla-jitter)# exit`	Exits UDP jitter configuration submode and returns to global configuration mode.

	Command or Action	Purpose
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

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

What to Do Next

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.

If you with configure and schedule a UDP jitter operation with additional characteristics, perform the task in the "Configuring and Scheduling a UDP Jitter Operation with Additional Characteristics" section on page 6.

Configuring and Scheduling a UDP Jitter Operation with Additional Characteristics

Perform this task to configure and schedule a UDP jitter operation with additional parameters.

Restrictions

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. See the CISCO-DATA-COLLECTION-MIB (available from http://www.cisco.com/go/mibs).

Note The **tos** command defines the type of service (ToS) byte in the IPv4 header of an IP SLAs operation and is valid only in IPv4 networks. The **traffic-class** command defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

The **flow-label** command defines the value in the flow label field in the IPv6 header for a supported IP SLAs operation and is valid only in IPv6 networks.

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. **tos** *number*
    or
    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.
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. • The default number of packets (**num-packets**) sent is 10. • The default **interval** between packets is 20 milliseconds. • The **control disable** keyword combination should only be used if you are disabling the IP SLAs control protocol on both the source and target routers. The IP SLAs control protocol is enabled by default. • After entering this command, the command-line interface (CLI) enters IP SLA jitter configuration mode to allow you to specify optional characteristics for the operation.
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.

	Command or Action	Purpose
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* **Example:** `Router(config-ip-sla-jitter)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
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	**tos** *number*
	or
	traffic-class *number*
	
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	or
	
	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.

	Command or Action	Purpose
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.
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

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

What to Do Next

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 the IP SLAs UDP Jitter Operation

This section provides the following configuration example:

Configuring a UDP Jitter Operation: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to configuring IP SLAs UDP Jitter operations.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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	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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs UDP Jitter Operation

Table 2 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 2 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 2 Feature Information for the IP SLAs UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH	The Cisco IOS 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)	12.2(33)SRC, 12.2(33)SB, 12.4(20)T	Support was added for operability in IPv6 networks.

IP SLAs—Analyzing VoIP Service Levels Using the UDP Jitter Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This document describes how to use the Cisco IOS IP Service Level Agreements (SLAs) 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 IOS devices in the network.

Cisco IOS IP SLAs is an embedded feature set in Cisco IOS software that allows you to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce occurrences of network congestion or outages. IP SLAs uses active traffic monitoring for measuring network performance. The accuracy of measured data is enhanced by enabling the IP SLAs Responder, available in Cisco routers, on the destination device.

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 for the IP SLAs VoIP UDP Jitter Operation" section on page 17.

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

Contents

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Prerequisites for IP SLAs VoIP UDP Jitter Operations

To use this feature, your networking devices on both ends of the connection must support Cisco IOS IP SLAs. Cisco IOS IP SLAs is an integrated feature set in Cisco IOS software.

Restrictions for IP SLAs VoIP UDP Jitter Operations

This feature uses UDP traffic to generate approximate Voice over IP scores. It does not provide support for the Real-Time Transport Protocol (RTP).

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.

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.

Note 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 VoIP UDP Jitter Operations

To use the IP SLAs VoIP UDP Operation feature, you should understand the following concepts:

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. Table 1, taken from G.113 (02/96), shows how sample ICPIF values are expected to correspond to subjective quality judgement.

Table 1 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. Table 2 shows MOS ratings and the corresponding description of quality for each value.

Table 2 MOS Ratings

Score	Quality	Description of Quality Impairment
5	Excellent	Imperceptible
4	Good	Just perceptible, but not annoying
3	Fair	Perceptible and slightly annoying
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 IOS 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 Table 3 for specifics.) However, you are given the option, if needed, to manually configure these parameters in the syntax of the **udp-jitter** command.

Table 3 shows the default parameters that are configured for the operation by codec.

Table 3 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 IOS 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. Table 4 shows sample correspondences between the one-way delay measured by IP SLAs and Delay Impairment Factor values.

Table 4 Sample Correspondence of One-Way Delay to ICPIF Delay Impairment

One-Way Delay (ms)	Delay Impairment Factor
50	1
100	2
150	4
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. Table 5 shows sample correspondences between the packet loss measured by IP SLAs and Equipment Impairment Factor values.

Table 5 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 Dactor (short for Access Advantage Factor) because it attempts to balance an increased access advantage against a decline in voice quality.

Table 6, adapted from ITU-T Rec. G.113, defines a set of provisional maximum values for *A* in terms of the service provided.

Table 6 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 Table 6 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. Table 7 shows the resulting MOS values that will be generated for corresponding ICPIF values.

Table 7 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 the IP SLAs VoIP UDP Jitter Operation

This section contains the following procedure:

- Configuring the IP SLAs VoIP UDP Jitter Operation

Configuring the IP SLAs VoIP UDP Jitter Operation

Perform this task to return VoIP scores with IP SLAs VoIP UDP jitter operation statistics.

The VoIP-specific implementation of the IP SLAs UDP jitter operation contains different configuration options than the standard UDP jitter operation. As soon as you specify the **codec** keyword in the **udp-jitter** command syntax, you are configuring the VoIP-specific implementation of the jitter operation.

Restrictions

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**

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.

Note The **tos** command defines the type of service (ToS) byte in the IPv4 header of an IP SLAs operation and is valid only in IPv4 networks. The **traffic-class** command defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

The **flow-label** command defines the value in the flow label field in the IPv6 header for a supported IP SLAs operation and is valid only in IPv6 networks.

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. **tos** *number*
    or
    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* **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	**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. • For the *codec-type* argument, use one of the following keywords: – **g711alaw**—64 kbps PCM compression method – **g711ulaw**—64 kbps PCM compression method – **g729a**—8 kbps CS-ACELP compression method • 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 value you specify for the **advantage-factor** will be subtracted from the measured impairment values. You can use this option to correct the ICPIF and MOS values for network conditions. The default advantage factor (expectation factor) is 0. • When configuring a jitter operation that uses a codec type, the destination port number should be an even numbered port in the range 16384 to 32766 or 49152 to 65534. • Do not use the **control** keyword with this command. The **control disable** keyword combination will disable IP SLAs control packets and cause the operation to malfunction. The default is **control enable**. • After entering this command, the command-line interface (CLI) enters IP SLA jitter configuration mode to allow you to specify optional characteristics for the operation.
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.

	Command or Action	Purpose
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* **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 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	**tos** *number*
	or
	traffic-class *number*
	
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	or
	
	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.

	Command or Action	Purpose
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**] **Example:** `Router(config)# ip sla schedule 5 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
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

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

What to Do Next

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 VoIP UDP Jitter Operations

In the following examples, a VoIP UDP jitter (codec) operation is configured, then output from the corresponding show commands is given. This example assumes that the IP SLAs Responder is enabled on the device at 209.165.200.225.

- IP SLAs VoIP UDP Operation Configuration: Example, page 13
- IP SLAs VoIP UDP Operation Statistics Output: Example, page 14

IP SLAs VoIP UDP Operation Configuration: Example

```
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.

IP SLAs VoIP UDP Operation Statistics Output: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs VoIP UDP Jitter Operation feature.

Related Documents

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
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*
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	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

Full support for these standards 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.

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

RFCs

RFC[1]	Title
RFC 768	*User Datagram Protocol*
RFC 1889	*RTP: A Transport Protocol for Real-Time Applications*

1. Full support by this feature for listed RFCs is not claimed.

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs VoIP UDP Jitter Operation

Table 8 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 8 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 8 Feature Information for the IP SLAs VoIP UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH	The Cisco IOS 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)	12.2(33)SRC, 12.2(33)SB, 12.4(20)T	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.[1]

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

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

IP SLAs—LSP Health Monitor with LSP Discovery

First Published: February 27, 2007
Last Updated: August 25, 2008

The Cisco IOS IP Service Level Agreements (SLAs) label switched path (LSP) Health Monitor with LSP Discovery feature provides the capability 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. The LSP Health Monitor feature also allows you to perform multioperation scheduling of IP SLAs operations and supports proactive threshold monitoring through SNMP trap notifications and syslog messages.

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 for the LSP Health Monitor" section on page 42.

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

Contents

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Prerequisites for the LSP Health Monitor

- 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. For more information about the MPLS LSP Ping feature, see the "Related Documents" section on page 39.
- 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 the LSP Health Monitor

- The LSP Health Monitor with LSP Discovery feature supports Layer 3 MPLS VPNs only.
- 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.
- 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.
- The LSP discovery option does not support IP SLAs LSP traceroute operations.
- The LSP discovery option does not support IP SLAs VCCV operations.

Information About the LSP Health Monitor

To use the LSP Health Monitor feature, you should understand the following concepts:

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. For more information on how to configure the LSP Health Monitor, see the "Configuring the LSP Health Monitor Without LSP Discovery" section on page 12 and "Configuring the LSP Health Monitor with LSP Discovery" section on page 17.

Note 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 on page 5.

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 on page 6.

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 on page 10.

   Depending on the proactive threshold monitoring configuration options chosen, SNMP trap notifications or syslog messages will be 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 on page 11.

   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 "The LSP Discovery Process" section on page 6. 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 (using the **access-list** command in global configuration mode) 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.

For more information about configuring standard IP access lists, see the "Related Documents" section on page 39.

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.

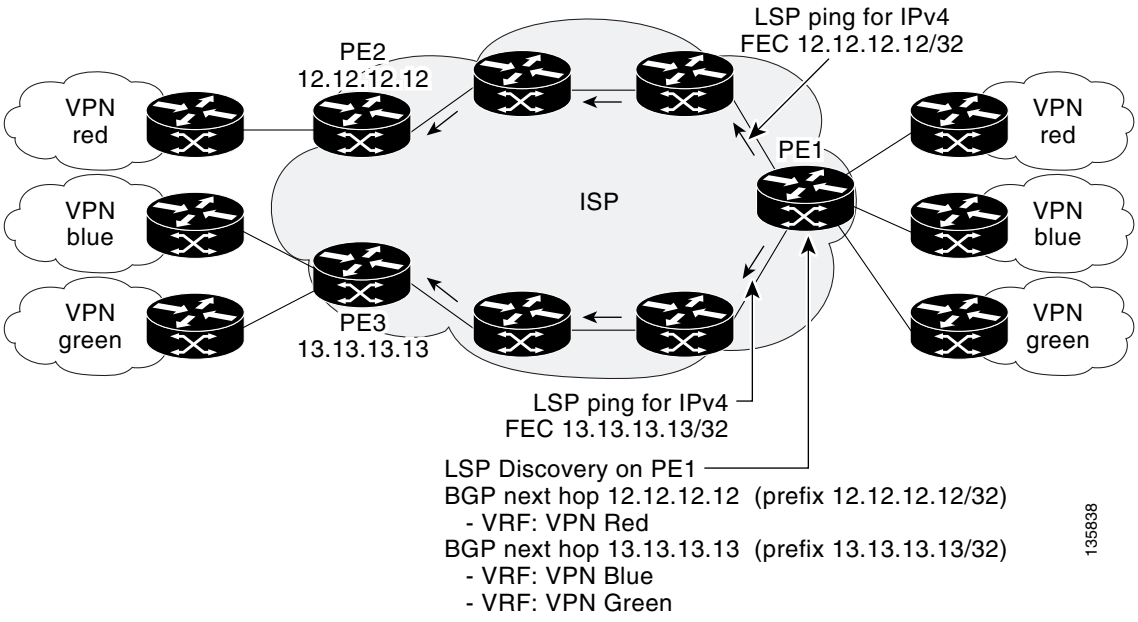
Discovery of Neighboring PE Routers

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.

Figure 1 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. For more information about the MPLS LSP Ping feature, see the "Related Documents" section on page 39.

Figure 1 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 on page 5.

   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 on page 7.

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.

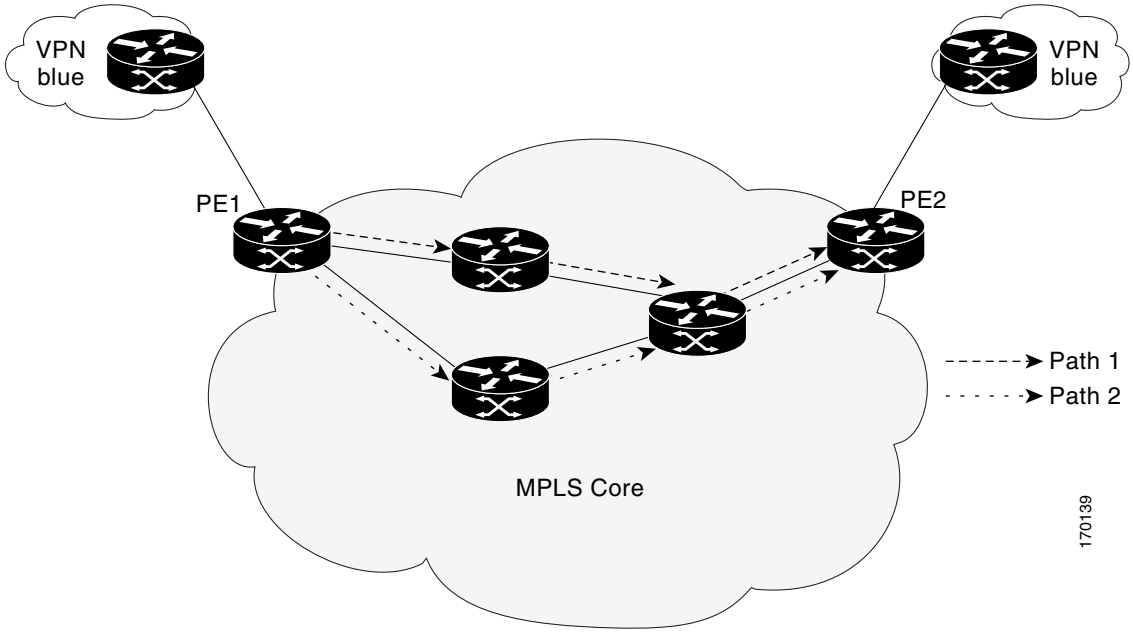
Note For a given LSP Health Monitor operation, the user can define the maximum number of BGP next hop neighbors that can be concurrently undergoing LSP discovery.

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.

For information about proactive threshold monitoring and multioperation scheduling of IP SLAs operations created through the LSP discovery process, see the "Proactive Threshold Monitoring for the LSP Health Monitor" section on page 10 and "Multioperation Scheduling for the LSP Health Monitor" section on page 11.

Figure 2 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.

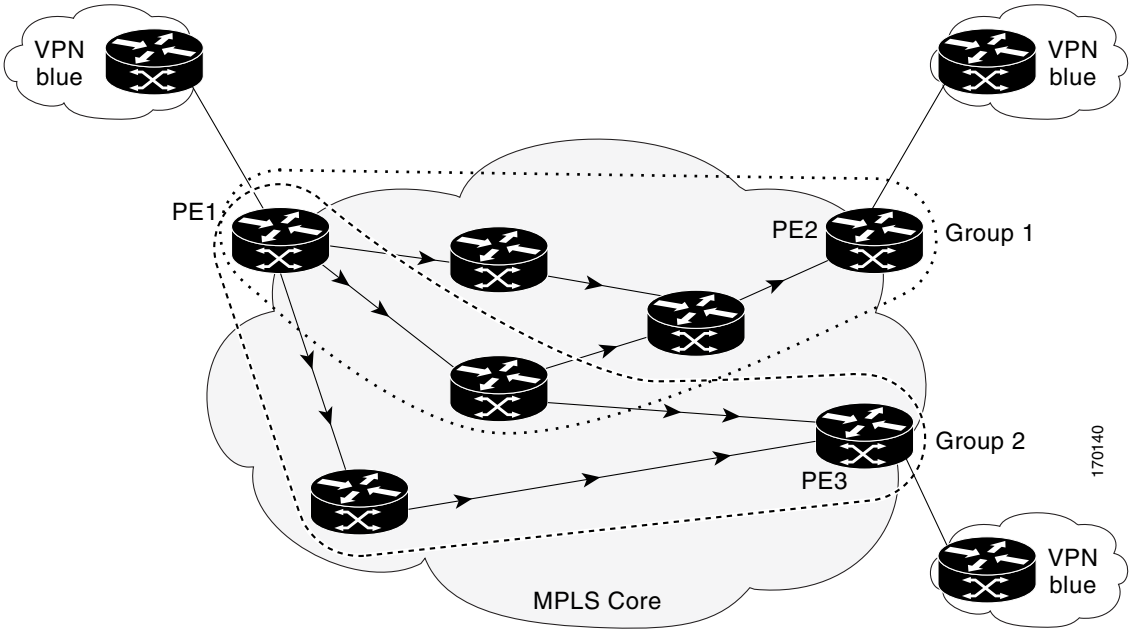
Figure 2 LSP Discovery for a Simple VPN



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). Figure 3 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 3 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 IOS 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.

For more information on how to configure IP SLAs operations using the LSP Health Monitor, see the "Configuring the LSP Health Monitor Without LSP Discovery" section on page 12 and the "Configuring the LSP Health Monitor with LSP Discovery" section on page 17. For more information on how to manually configure an individual IP SLAs LSP ping or LSP traceroute operation, see the "Manually Configuring an IP SLAs LSP Ping or LSP Traceroute Operation" section on page 21.

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. For more information about the MPLS LSP Ping and MPLS LSP Traceroute management tools, see the "Related Documents" section on page 39.

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

IP SLAs VCCV Operation

The IP SLAs VCCV operation supports Virtual Circuit Connectivity Verification (VCCV) for Pseudo-Wire Emulation Edge-to-Edge (PWE3) services across MPLS networks. The IP SLAs VCCV operation type is based on the **ping mpls pseudowire** command, which checks MPLS LSP connectivity across an Any Transport over MPLS (AToM) virtual circuit (VC) by sending a series of pseudo-wire ping operations to the specified destination PE router.

When MPLS LSP connectivity checking is performed through an IP SLAs VCCV operation (rather than through the **ping mpls** command with the **pseudowire** keyword), you can use the IP SLA proactive threshold monitoring and multioperation scheduling capabilities:

- You can configure an IP SLAs VCCV operation to perform proactive monitoring of PWE3 services and detection of faults in those services. An IP SLAs VCCV operation can send out a Simple Network Management Protocol (SNMP) trap if round-trip time (RTT) thresholds are violated, if the connection is lost, or if a command response timeout occurs. In addition, RTT data is available to be reported as statistics. For more information, see the "Proactive Threshold Monitoring for the LSP Health Monitor" section on page 10.
- Through the use of the **ip sla schedule** command, you can schedule an IP SLAs VCCV operation to periodically perform VCCV for PWE3 services. For more information, see the "Multioperation Scheduling for the LSP Health Monitor" section on page 11.

For information about how to configure an IP SLAs VCCV operation using the LSP Health Monitor, see the "Manually Configuring an IP SLAs VCCV Operation" section on page 25 and the "Manually Configuring an IP SLAs VCCV Operation: Example" section on page 38.

Note The LSP discovery option does not support the IP SLAs VCCV operation.

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. For more information about proactive threshold monitoring for Cisco IOS IP SLAs, see the "Related Documents" section on page 39.

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.

Table 1 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 1 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.
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.

Note 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. For more information about scheduling a group of standard IP SLAs operations, see the "Related Documents" section on page 39.

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.

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.

How to Use the LSP Health Monitor

This section contains the following tasks:

- Configuring the LSP Health Monitor Without LSP Discovery, page 12 (required)
- Configuring the LSP Health Monitor with LSP Discovery, page 17 (optional)
- Manually Configuring an IP SLAs LSP Ping or LSP Traceroute Operation, page 21 (optional)
- Manually Configuring an IP SLAs VCCV Operation, page 25 (optional)
- Verifying and Troubleshooting the LSP Health Monitor, page 28 (optional)

Configuring the LSP Health Monitor Without LSP Discovery

Perform this task to configure the operation parameters, reaction conditions, and scheduling options for an LSP Health Monitor operation without LSP discovery. If the LSP discovery option is disabled, only a single path between the source PE router and each BGP next hop neighbor is discovered. The LSP discovery option is disabled by default. The IP SLAs measurement statistics are stored on the source PE router.

Prerequisites

The LSP Health Monitor must be configured on a PE router.

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*]
   or
   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. **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**}]
24. **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.

	Command or Action	Purpose
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. The default time interval is 300 seconds. **Note** The default interval of time that BGP neighbor statistics are updated is different for the IP SLAs LSP Health Monitor database and the BGP next hop neighbor discovery database. Use the **scan-interval** command to set the timer for the IP SLAs LSP Health Monitor database. Use the **mpls discovery vpn interval** command to set the timer for the BGP next hop neighbor discovery database.
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	**type echo** [**ipsla-vrf-all** | **vrf** *vpn-name*]
	or
	type pathEcho [**ipsla-vrf-all** | **vrf** *vpn-name*]
	
	Example:
	`Router(config-auto-ip-sla-mpls)# type echo ipsla-vrf-all`
	or
	
	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.

	Command or Action	Purpose
Step 8	**scan-interval** *minutes* **Example:** `Router(config-auto-ip-sla-mpls-params)# scan-interval 5`	(Optional) Specifies the time interval (in minutes) at which the LSP Health Monitor checks the scan queue for BGP next hop neighbor updates. The default time interval is 240 minutes. At each interval, a new IP SLAs operation is automatically created for each newly discovered BGP next hop neighbor listed in the LSP Health Monitor scan queue. **Note** The default interval of time that BGP neighbor statistics are updated is different for the IP SLAs LSP Health Monitor database and the BGP next hop neighbor discovery database. Use the **scan-interval** command to set the timer for the IP SLAs LSP Health Monitor database. Use the **mpls discovery vpn interval** command to set the timer for the BGP next hop neighbor discovery 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. In other words, each time the LSP Health Monitor checks the scan queue for updates, it deletes IP SLAs 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. **Note** 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. The default experimental field value is 0.
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. The default IP address is 127.0.0.0.

	Command or Action	Purpose
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. The default DSCP value is 0.
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. For an IP SLAs LSP ping operation, the default is 100 bytes.
Step 16	**secondary-frequency** {**both** | **connection-loss** | **timeout**} *frequency* **Example:** `Router(config-auto-ip-sla-mpls-params)# 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.
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. The default timeout value is 5000 ms. **Note** The default timeout values vary by operation type.
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.

	Command or Action	Purpose
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	**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 24	**exit** **Example:** `Router(config)# exit`	Exits global configuration submode and returns to privileged EXEC mode.

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.

Configuring the LSP Health Monitor with LSP Discovery

Perform this task to configure the operation parameters, reaction conditions, and scheduling options for an LSP Health Monitor operation with LSP discovery. If the LSP discovery option is enabled, the equal-cost multipaths between the source PE router and each BGP next hop neighbor are discovered. If the LSP discovery option is disabled, only a single path between the source PE router and each BGP next hop neighbor is discovered. The LSP discovery option is disabled by default. The IP SLAs measurement statistics are stored on the source PE router.

Prerequisites

The LSP Health Monitor must be configured on a PE router.

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. See Steps 7 through 21 in the "Configuring the LSP Health Monitor Without LSP Discovery" section on page 12.
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. **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**}]
22. **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. The default time interval is 300 seconds. **Note** The default interval of time that BGP neighbor statistics are updated is different for the IP SLAs LSP Health Monitor database and the BGP next hop neighbor discovery database. Use the **scan-interval** command to set the timer for the IP SLAs LSP Health Monitor database. Use the **mpls discovery vpn interval** command to set the timer for the BGP next hop neighbor discovery database.
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. See Steps 7 through 21 in the "Configuring the LSP Health Monitor Without LSP Discovery" section on page 12.	(Optional) Configures optional parameters for an IP SLAs LSP echo operation.
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* **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# hours-of-statistics-kept 1`	(Optional) Sets the number of hours for which LSP discovery group statistics are maintained for an LSP Health Monitor operation.
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.

	Command or Action	Purpose
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** **Example:** `Router(config-auto-ip-sla-mpls-lpd-params)# exit`	Exits LSP discovery parameters configuration submode and returns to MPLS parameters configuration mode.
Step 18	**exit** **Example:** `Router(config-auto-ip-sla-mpls-params)# exit`	Exits MPLS parameters configuration mode and returns to global configuration mode.

	Command or Action	Purpose
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	**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 22	**exit** **Example:** `Router(config)# exit`	Exits global configuration submode and returns to privileged EXEC mode.

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 an IP SLAs LSP Ping or LSP Traceroute Operation

Perform this task to manually configure an IP SLAs LSP ping or LSP traceroute operation.

Note The LSP traceroute operation does not support the **secondary-frequency** command.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **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**}}]
   or
   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** **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.

	Command or Action	Purpose

Step 4	**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**}}]
	or
	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`
	or
	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. The default experimental field value is 0.
Step 6	**request-data-size** *bytes* **Example:** `Router(config-sla-monitor-lspPing)# request-data-size 200`	(Optional) Specifies the protocol data size for a request packet of an IP SLAs operation. For an IP SLAs LSP ping operation, the default is 100 bytes.
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. **Note** The LSP traceroute operation does not support the **secondary-frequency** 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.

	Command or Action	Purpose
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. The default timeout value is 5000 ms. **Note** The default timeout values vary by operation type.
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 react connectionLoss threshold-type consecutive 3 action-type traponly`	(Optional) Configures certain actions to occur based on events under the control of Cisco IOS IP SLAs.
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

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.

Manually Configuring an IP SLAs VCCV Operation

Perform this task to manually configure an IP SLAs Virtual Circuit Connectivity Verification (VCCV) operation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **mpls lsp ping pseudowire** *peer-ipaddr vc-id* [**source-ipaddr** *source-ipaddr*]
5. **exp** *exp-bits*
6. **frequency** *seconds*
7. **request-data-size** *bytes*
8. **secondary-frequency** {**both** | **connection-loss** | **timeout**} *frequency*
9. **tag** *text*
10. **threshold** *milliseconds*
11. **timeout** *milliseconds*
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** **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 777`	Begins configuring an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**mpls lsp ping pseudowire** *peer-ipaddr vc-id* [**source-ipaddr** *source-ipaddr*] **Example:** `Router(config-ip-sla)# mpls lsp ping pseudowire 192.168.1.103 123 source-ipaddr 192.168.1.102`	Configures the IP SLAs operation as an LSP pseudo-wire ping and enters VCCV configuration mode.
Step 5	**exp** *exp-bits* `Router(config-sla-vccv)# exp 5`	(Optional) Specifies the experimental field value in the header for an echo request packet of an IP SLAs operation. The default experimental field value is 0.
Step 6	**frequency** *seconds* **Example:** `Router(config-sla-vccv)# frequency 120`	(Optional) Specifies the rate at which a specified IP SLAs operation repeats. The default value is 60 seconds.
Step 7	**request-data-size** *bytes* **Example:** `Router(config-sla-vccv)# request-data-size 200`	(Optional) Specifies the protocol data size for a request packet of an IP SLAs operation. For an IP SLAs LSP ping operation, the default is 100 bytes.
Step 8	**secondary-frequency** {**both** | **connection-loss** | **timeout**} *frequency* **Example:** `Router(config-sla-vccv)# 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.
Step 9	**tag** *text* **Example:** `Router(config-sla-vccv)# tag testgroup`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 10	**threshold** *milliseconds* `Router(config-sla-vccv)# threshold 6000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 11	**timeout** *milliseconds* **Example:** `Router(config-sla-vccv)# timeout 7000`	(Optional) Specifies the amount of time the IP SLAs operation waits for a response from its request packet. The default timeout value is 5000 ms. **Note** The default timeout values vary by operation type.
Step 12	**exit** **Example:** `Router(config-sla-vccv)# exit`	Exits VCCV configuration mode 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 777 react connectionLoss threshold-type consec-utive 3 action-type traponly`	(Optional) Configures certain actions to occur based on events under the control of Cisco IOS IP SLAs.
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 777 life forev-er 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

Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an individual IP SLAs PWE3 service via VCCV 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 the LSP Health Monitor

Perform this task to verify and troubleshoot the LSP Health Monitor.

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.
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.
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.

	Command or Action	Purpose
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 the LSP Health Monitor

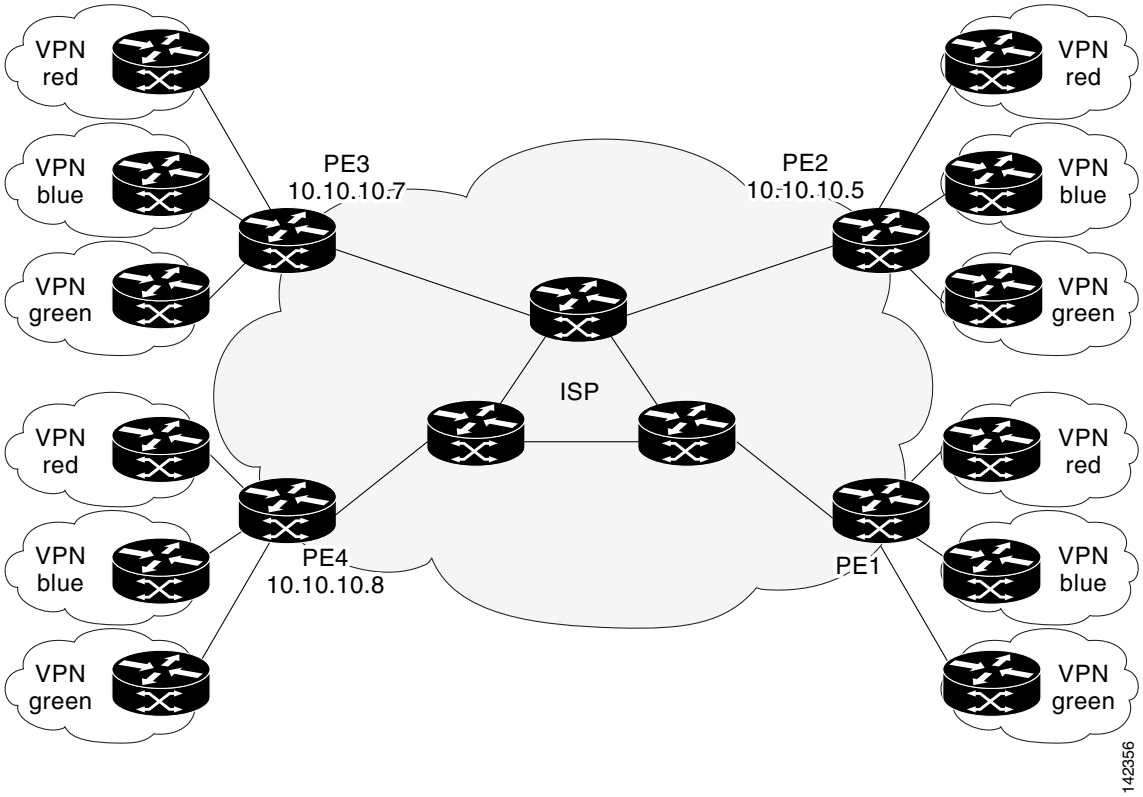
This section provides the following configuration examples:

- Configuring and Verifying the LSP Health Monitor Without LSP Discovery: Example, page 30
- Configuring and Verifying the LSP Health Monitor with LSP Discovery: Example, page 34
- Manually Configuring an IP SLAs LSP Ping Operation: Example, page 37
- Manually Configuring an IP SLAs VCCV Operation: Example, page 38

Configuring and Verifying the LSP Health Monitor Without LSP Discovery: Example

Figure 4 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 4 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 Figure 4) 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
```

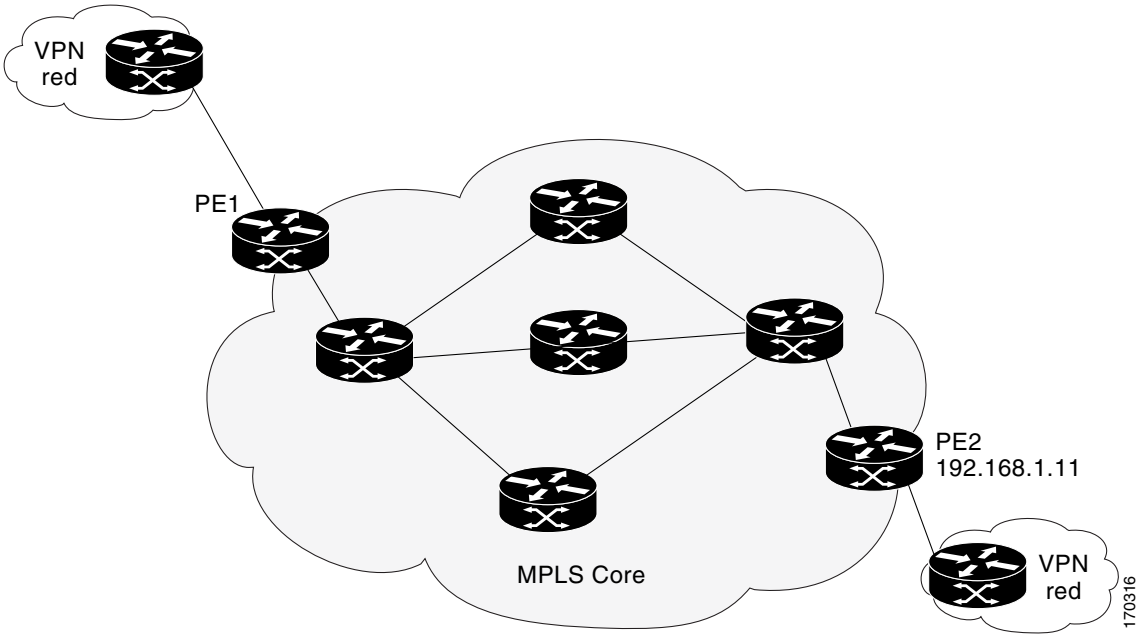
```
PE1# debug ip sla mpls-lsp-monitor

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
```

Configuring and Verifying the LSP Health Monitor with LSP Discovery: Example

Figure 5 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 5 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 Figure 5) 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
```

Manually Configuring an IP SLAs LSP Ping Operation: Example

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
```

Manually Configuring an IP SLAs VCCV Operation: Example

The following example shows how to manually configure an IP SLAs VCCV operation in conjunction with the proactive threshold monitoring and multioperation scheduling capabilities of the LSP Health Monitor.

Note In this example, a VC with the identifier 123 has already been established between the PE router and its peer at IP address 192.168.1.103.

IP SLAs VCCV operation 777 is configured with operation parameters and reaction conditions, and it is scheduled to begin immediately and run indefinitely.

```
ip sla 777
 mpls lsp ping pseudowire 192.168.1.103 123
  exp 5
  frequency 120
  secondary-frequency timeout 30
  tag testgroup
  threshold 6000
  timeout 7000
  exit
!
 ip sla reaction-configuration 777 react rtt threshold-value 6000 3000 threshold-type
immediate 3 action-type traponly
 ip sla reaction-configuration 777 react connectionLoss threshold-type immediate
action-type traponly
 ip sla reaction-configuration 777 react timeout threshold-type consecutive 3 action-type
traponly
 ip sla logging traps
!
 ip sla schedule 777 life forever start-time now
 exit
```

RTT Thresholds

The **threshold** command configures 6000 milliseconds as the amount of time for a rising threshold to be declared on the monitored pseudo-wire. The first **ip sla reaction-configuration** command specifies that an SNMP logging trap is to be sent immediately if the round-trip time violates the upper threshold of 6000 milliseconds or the lower threshold of 3000 milliseconds.

Connection Loss

The second **ip sla reaction-configuration** command specifies that an SNMP logging trap is to be sent immediately if a connection loss occurs for the monitored pseudo-wire.

Response Timeout

The **timeout** command configures 7000 seconds as the amount of time that VCCV operation 777 waits for a response from its request packet before a timeout is declared. The **secondary-frequency** command specifies that, if a timeout occurs, the measurement frequency of the operation repeats is to be increased from 120 seconds (the initial measurement frequency specified using the **frequency** command) to a faster rate of 30 seconds. The third **ip sla reaction-configuration** command specifies that an SNMP logging trap is to be sent if three consecutive timeouts occur.

Additional References

The following sections provide references related to the LSP Health Monitor with LSP Discovery feature.

Related Documents

Related Topic	Document Title
MPLS LSP ping and LSP traceroute management tools	*MPLS LSP Ping/Traceroute for LDP/TE, and LSP Ping for VCCV*, Cisco IOS feature
MPLS LSP discovery management tool	*MPLS EM—MPLS LSP Multipath Tree Trace*, Cisco IOS feature
Configuring standard IP access lists	"Creating an IP Access List and Applying It to an Interface" chapter of the *Cisco IOS Security Configuration Guide*
Multioperation scheduling for Cisco IOS IP SLAs	"IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*
Proactive threshold monitoring for Cisco IOS IP SLAs	"IP SLAs—Proactive Threshold Monitoring of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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
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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS IP SLA Command Reference* at http://www.cisco.com/en/US/docs/ios/ipsla/command/reference/sla_book.html. For information about all Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the *Cisco IOS Master Commands List* at http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html.

- **access-list (IP SLA)**
- **auto ip sla mpls-lsp-monitor**
- **auto ip sla mpls-lsp-monitor reaction-configuration**
- **auto ip sla mpls-lsp-monitor reset**
- **auto ip sla mpls-lsp-monitor schedule**
- **debug ip sla mpls-lsp-monitor**
- **delete-scan-factor**
- **exp (IP SLA)**
- **force-explicit-null**
- **frequency (IP SLA)**
- **history buckets-kept**
- **history distributions-of-statistics-kept**

- **history enhanced**
- **history filter**
- **history hours-of-statistics-kept**
- **history lives-kept**
- **history statistics-distribution-interval**
- **interval (LSP discovery)**
- **lsp-selector**
- **lsp-selector-base**
- **maximum-sessions**
- **mpls discovery vpn interval**
- **mpls discovery vpn next-hop**
- **mpls lsp ping ipv4**
- **mpls lsp ping pseudowire**
- **mpls lsp trace ipv4**
- **owner**
- **path-discover**
- **reply-dscp-bits**
- **reply-mode**
- **request-data-size**
- **scan-interval**
- **scan-period**
- **secondary-frequency**
- **session-timeout (LSP discovery)**
- **show ip sla mpls-lsp-monitor collection-statistics**
- **show ip sla mpls-lsp-monitor configuration**
- **show ip sla mpls-lsp-monitor lpd operational-state**
- **show ip sla mpls-lsp-monitor neighbors**
- **show ip sla mpls-lsp-monitor scan-queue**
- **show ip sla mpls-lsp-monitor summary**
- **show mpls discovery vpn**
- **tag (IP SLA)**
- **threshold (IP SLA)**
- **timeout (IP SLA)**
- **ttl (IP SLA)**
- **type echo (MPLS)**
- **type pathEcho (MPLS)**

Feature Information for the LSP Health Monitor

Table 2 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 2 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 2 Feature Information for the LSP Health Monitor

Feature Name	Releases	Feature Information
IP SLAs—LSP Health Monitor	12.2(27)SBC, 12.2(28)SB, 12.4(6)T, 12.2(33)SRA, 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	12.2(31)SB2, 12.2(33)SB, 12.2(33)SRB	For software releases in which this feature was already introduced, new command-line interface (CLI) was implemented that replaces the CLI introduced in the earlier releases.
IP SLAs—LSP Health Monitor with LSP Discovery	12.2(31)SB2, 12.2(33)SRB, Cisco IOS XE Release 2.2	The LSP discovery capability was added.
IP SLAs for MPLS Pseudo Wire (PWE3) via VCCV	12.2(33)SRC, 12.2(33)SB	The IP SLAs VCCV operation was added to support Virtual Circuit Connectivity Verification (VCCV) for Pseudo-Wire Emulation Edge-to-Edge (PWE3) services across MPLS networks.

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

IP SLAs for Metro-Ethernet

First Published: February 27, 2007
Last Updated: November 20, 2009

The IP Service Level Agreements (SLAs) for Metro-Ethernet feature provides the capability to gather network performance metrics in service provider Ethernet networks. This feature integrates Cisco IOS 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. Available statistical measurements for the IP SLAs Ethernet operation include round-trip time, jitter (interpacket delay variance), and packet loss.

The IP SLAs for Metro-Ethernet feature also allows you to perform multioperation scheduling of IP SLAs operations and supports proactive threshold violation monitoring through Simple Network Management Protocol (SNMP) trap notifications and syslog messages.

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 for the IP SLAs Ethernet Operation" section on page 15.

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

Contents

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Prerequisites for the IP SLAs Ethernet Operation

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.

Note The destination devices do not require the IP SLAs Responder to be enabled.

Restrictions for the IP SLAs Ethernet Operation

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 the IP SLAs Ethernet Operation

To configure an IP SLAs Ethernet operation, you should understand the following concepts:

Benefits of the IP SLAs Ethernet Operation

- End-to-end connectivity measurements for determining network availability or testing network connectivity in service provider Ethernet networks
- Proactive threshold violation monitoring through SNMP trap notifications and syslog messages
- Reduced network troubleshooting time for service provider Ethernet networks
- Creation of IP SLAs Ethernet ping and Ethernet jitter operations based on network topology
- Discovery of existing maintenance endpoints (MEPs) in a given Ethernet CFM maintenance domain and EVC or VLAN based on the Ethernet CFM database
- Multioperation scheduling of IP SLAs operations

Ethernet CFM

Ethernet CFM is an end-to-end per-service-instance Ethernet-layer operation, administration, and management (OAM) protocol. For more information about this feature, see the documentation for the Ethernet CFM feature. (See the "Related Documents" section on page 12 for the location of this document.)

IP SLAs Ethernet Operation Basics

Note 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 for the IP SLAs Ethernet Operation" section on page 15.

The IP SLAs for Metro-Ethernet feature integrates the IP SLAs software subsystem with the Ethernet CFM software subsystem to provide 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 ping or auto Ethernet jitter operation 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 also allows you to perform multioperation scheduling of IP SLAs operations and supports proactive threshold violation monitoring through SNMP trap notifications and syslog messages. For more information on these topics, see the "Related Documents" section on page 12.

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 the IP SLAs Ethernet Operation

This section contains the following tasks:

Configuring an IP SLAs Ethernet Operation with Endpoint Discovery

Perform this task to configure and schedule an IP SLAs auto Ethernet operation.

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*]
   or
   type jitter domain *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*] [**interval** *interframe-interval*] [**num-frames** *frames-number*]
5. **cos** *cos-value*
6. **owner** *owner-id*
7. **request-data-size** *bytes*
8. **tag** *text*
9. **threshold** *milliseconds*
10. **timeout** *milliseconds*
11. **exit**
12. **ip sla ethernet-monitor reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** {**none** | **trapOnly**}] [**threshold-type** {**average** [*number-of-measurements*] | **consecutive** [*occurrences*] | **immediate** | **never** | **xofy** [*x-value y-value*]}] [**threshold-value** *upper-threshold lower-threshold*]
13. **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**}]
14. **exit**
15. **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* **Example:** `Router(config)# ip sla ethernet-monitor 1`	Begins configuration for an IP SLAs auto Ethernet operation and enters IP SLA Ethernet monitor configuration mode.

Step 4	**type echo domain** *domain-name* {**evc** *evc-id* | **vlan** *vlan-id*} [**exclude-mpids** *mp-ids*]
	or
	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 echo domain testdomain vlan 34`
	or
	
	Example:
	`Router(config-ip-sla-ethernet-monitor)# type jitter domain testdomain evc testevc interval 20 num-frames 30`
		Configures an auto Ethernet operation to create Ethernet ping operations.
		or
		Configures an auto Ethernet operation to create Ethernet jitter operations.

Step 5	**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 6	**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 7	**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.

	Command or Action	Purpose
Step 8	**tag** *text* **Example:** `Router(config-ip-sla-ethernet-params)# tag TelnetPollSever1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 9	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-ethernet-params)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 10	**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 11	**exit** **Example:** `Router(config-ip-sla-ethernet-params)# exit`	Exits IP SLAs auto Ethernet parameters configuration submode and returns to global configuration mode.
Step 12	**ip sla ethernet-monitor reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** {**none** | **trapOnly**}] [**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 ethernet-monitor reaction-configuration 10 react connectionLoss threshold-type consecutive 3 action-type trapOnly`	Configures proactive threshold monitoring parameters for an IP SLAs auto Ethernet operation.
Step 13	**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`	Configures scheduling parameters for an IP SLAs auto Ethernet operation.

	Command or Action	Purpose
Step 14	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 15	**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.

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 display the results of an 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 an Individual IP SLAs Ethernet Operation

Perform this task to manually configure and schedule an individual IP SLAs Ethernet ping or Ethernet jitter operation.

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*}
   or
   ethernet jitter mpid *mp-id* **domain** *domain-name* {**evc** *evc-id* | **port** | **vlan** *vlan-id*} [**interval** *interframe-interval*] [**num-frames** *frames-number*]
5. **cos** *cos-value*
6. **frequency** *seconds*
7. **history** *history-parameter*
8. **owner** *owner-id*
9. **request-data-size** *bytes*
10. **tag** *text*
11. **threshold** *milliseconds*

12. **timeout** *milliseconds*
13. **exit**
14. **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*]
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**
17. **show ip sla configuration** [*operation-number*]
18. **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*}
	or
	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 echo mpid 23 domain testdomain vlan 34`
	or
	
	Example:
	`Router(config-ip-sla)# ethernet jitter mpid 23 domain testdomain evc testevc interval 20 num-frames 30`
		Configures the IP SLAs operation as an Ethernet ping operation and enters Ethernet echo configuration mode.
		or
		Configures the IP SLAs operation as an Ethernet jitter operation and enters Ethernet jitter configuration mode.

Step 5	**cos** *cos-value* **Example:** `Router(config-ip-sla-ethernet-echo)# cos 2`	(Optional) Sets the class of service for an IP SLAs Ethernet operation.

	Command or Action	Purpose
Step 6	**frequency** *seconds* **Example:** `Router(config-ip-sla-ethernet-echo)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 7	**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 8	**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 9	**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 10	**tag** *text* **Example:** `Router(config-ip-sla-ethernet-echo)# tag TelnetPollSever1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 11	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-ethernet-echo)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 12	**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 13	**exit** **Example:** `Router(config-ip-sla-ethernet-echo)# exit`	Exits IP SLAs Ethernet monitor configuration submode and returns to global configuration mode.

	Command or Action	Purpose
Step 14	**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 1 react jitterAvg threshold-value 5 2 action-type trap threshold-type immediate`	Configures proactive threshold monitoring parameters for an IP SLAs operation.
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 life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 16	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 17	**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 18	**show ip sla application** **Example:** `Router# show ip sla application`	(Optional) Displays global information about supported IP SLAs features.

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.

What to Do Next

To display the results of an 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.

Configuration Examples for the IP SLAs Ethernet Operation

This section provides the following configuration examples:

Configuring an IP SLAs Ethernet Operation with Endpoint Discovery: Examples

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 EVC identified as testevc. 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 evc testevc
!
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
```

Manually Configuring an Individual IP SLAs Ethernet Operation: Examples

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 EVC is identified as testevc. 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 evc testevc
!
ip sla reaction-configuration 5 react connectionLoss threshold-type consecutive 3
action-type trapOnly
!
ip sla schedule 5 start-time now
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs for Metro-Ethernet feature.

Related Documents

Related Topic	Document Title
Ethernet CFM	"Configuring Ethernet Connectivity Fault Management in a Service Provider Network" chapter of the *Cisco IOS Carrier Ethernet Configuration Guide*
Multioperation scheduling for Cisco IOS IP SLAs	"IP SLAs—Multiple Operation Scheduling" chapter of the *Cisco IOS IP SLAs Configuration Guide*
Proactive threshold monitoring for Cisco IOS IP SLAs	"IP SLAs—Proactive Threshold Monitoring" chapter of the *Cisco IOS IP SLAs Configuration Guide*
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
Cisco IOS IP SLAs commands	*Cisco IOS IP SLAs Command Reference*

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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS IP SLA Command Reference* at http://www.cisco.com/en/US/docs/ios/ipsla/command/reference/sla_book.html. For information about all Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the *Cisco IOS Master Commands List* at http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html.

- **cos**
- **debug ip sla ethernet-monitor**
- **ethernet echo mpid**
- **ethernet jitter mpid**
- **ip sla ethernet-monitor**

- **ip sla ethernet-monitor reaction-configuration**
- **ip sla ethernet-monitor schedule**
- **request-data-size (Ethernet)**
- **show ip sla ethernet-monitor configuration**
- **type echo domain**
- **type jitter domain**

Feature Information for the IP SLAs Ethernet Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS, Catalyst OS, and Cisco IOS XE software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs Ethernet Operation

Feature Name	Releases	Feature Information
IP SLAs for Metro-Ethernet	12.2(33)SRB, 12.2(33)SB, 12.4(20)T, Cisco IOS XE Release 2.1, 12.2(33)SXI	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.
IP SLAs Metro-Ethernet 2.0 (EVC)	12.2(33)SRD	Support for Ethernet Virtual Circuits (EVCs) was added. The following sections provide information about this feature: • IP SLAs Ethernet Operation Basics • Configuring an IP SLAs Ethernet Operation with Endpoint Discovery • Manually Configuring an Individual IP SLAs Ethernet Operation • Configuring an IP SLAs Ethernet Operation with Endpoint Discovery: Examples • Manually Configuring an Individual IP SLAs Ethernet Operation: Examples
IP SLAs Metro-Ethernet 3.0 (CFM d8.1)	12.2(33)SRE	Support for port level statistical measurements was added. The following sections provide information about this feature: • IP SLAs Ethernet Operation Basics • Manually Configuring an Individual IP SLAs Ethernet Operation

IP SLAs—Analyzing IP Service Levels Using the UDP Echo Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS 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. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs UDP Echo Operation" section on page 14.

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

Contents

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Prerequisites for the IP SLAs UDP Echo Operation

Before configuring the IP SLAs UDP echo operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Restrictions for the IP SLAs UDP Echo Operation

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 the IP SLAs UDP Echo Operation

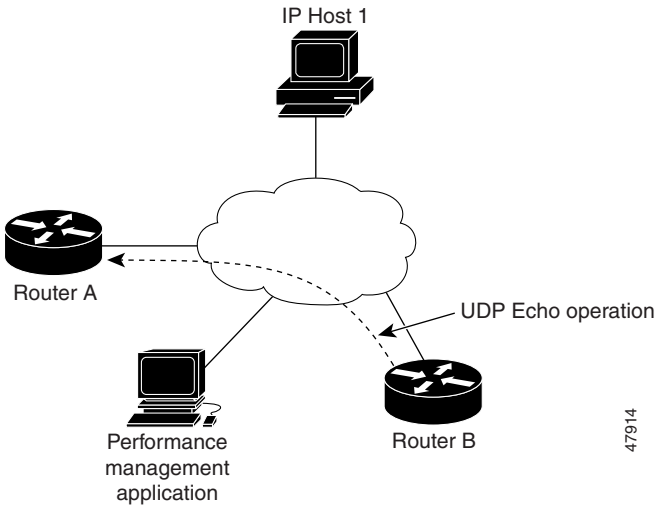
To perform the tasks required to monitor UDP performance using IP SLA, you should understand the following concept:

UDP Echo Operation

The UDP echo operation measures end-to-end response time between a Cisco router and devices using IP. UDP is a network layer (Layer 3) Internet protocol that is used for many IP services. UDP echo is used to measure response times and test end-to-end connectivity.

In Figure 1 Router A has been configured as an IP SLAs Responder and Router B is configured as the source IP SLAs device.

Figure 1 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 the IP SLAs UDP Echo Operation

This section contains the following procedures:

- Configuring the IP SLAs Responder on the Destination Device, page 3
- Configuring and Scheduling a UDP Echo Operation on the Source Device, page 4 (required)

Configuring the IP SLAs Responder on the Destination Device

Perform this task to enable the IP SLAs Responder on the destination Cisco device of a UDP echo operation. A UDP echo operation measures round-trip delay times and tests connectivity to Cisco and non-Cisco devices.

Prerequisites

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. **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:** `Router(config)# ip sla responder`	Enables IP SLAs Responder functionality on a Cisco device.
Step 4	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a UDP Echo Operation on the Source Device

To monitor UDP performance on a device, use the IP SLAs UDP echo operation. A UDP echo operation measures round-trip delay times and tests connectivity to Cisco and non-Cisco devices.

Perform one of the following tasks in this section, depending on whether you want to configure a basic UDP echo operation or configure a UDP echo operation with optional parameters:

- Configuring and Scheduling a Basic UDP Echo Operation on the Source Device, page 4
- Configuring and Scheduling a UDP Echo Operation with Optional Parameters on the Source Device, page 7

Prerequisites

If you are using the IP SLAs Responder, ensure that you have completed the "Configuring the IP SLAs Responder on the Destination Device" section on page 3 before you start this task.

Configuring and Scheduling a Basic UDP Echo Operation on the Source Device

Perform this task to enable a UDP echo operation without any optional parameters.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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**
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-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. • The **control disable** keyword combination should only be used if you are disabling the IP SLAs control protocol on both the source and target routers. The IP SLAs control protocol is enabled by default. • After entering this command, the command-line interface (CLI) enters IP SLA UDP echo configuration mode to allow you to specify optional characteristics for the operation.

	Command or Action	Purpose
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** **Example:** `Router(config-ip-sla-udp)# exit`	Exits IP SLA UDP 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 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.

Examples

The following example shows the configuration of 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
!
ip sla schedule 5 start-time now life forever.
```

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

What to Do Next

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 Echo Operation with Optional Parameters on the Source Device

Perform this task to enable a UDP echo operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note The **tos** command defines the type of service (ToS) byte in the IPv4 header of an IP SLAs operation and is valid only in IPv4 networks. The **traffic-class** command defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

The **flow-label** command defines the value in the flow label field in the IPv6 header for a supported IP SLAs operation and is valid only in IPv6 networks.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **tos** *number*
    or
    traffic-class *number*
20. **flow-label** *number*
21. **verify-data**
22. **exit**

23. **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**]
24. **exit**
25. **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-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 **dest-ipaddr** keyword and associated options to specify an IP address or designated IP name as the destination of the UDP probe. • Use the **dest-port** keyword and *port-number* value to specify the destination port number in the range from 1 to 65535. • Use the optional **source-ipaddr** keyword and associated options to specify an IP address or designated IP name as the source of the UDP operation. This configuration is useful when IP SLAs packets are to be routed within an IPsec or GRE tunnel. • Use the optional **source-port** keyword and *port-number* value to specify a source port number. • Use the optional **control** keyword to specify that the IP SLAs control protocol should be used when running this operation. The control protocol is required when the target device is a Cisco router that does not natively provide the UDP service. Use the **disable** keyword when you want to disable the control protocol. The control protocol is enabled by default.
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.

	Command or Action	Purpose
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.
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.

	Command or Action	Purpose
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* **Example:** `Router(config-ip-sla-udp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
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	**tos** *number*
	or
	traffic-class *number*
	
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	or
	
	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.

	Command or Action	Purpose
Step 23	**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 24	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 25	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the UDP echo operation number 5.

```
Router# show ip sla configuration 5

Complete configuration Table (includes defaults)
Entry number: 5
Owner: jdoe
Tag: FLL-RO
Type of operation to perform: udpEcho
Target address: 172.29.139.134
Source address: 0.0.0.0
Target port: 5000
Source port: 0
Request size (ARR data portion): 160
Operation timeout (milliseconds): 1000
Type Of Service parameters: 128
Verify data: No
Data pattern:
Vrf Name:
Control Packets: enabled
Operation frequency (seconds): 30
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): Forever
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:
Aggregation Interval:60 Buckets:2
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
```

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

What to Do Next

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 the IP SLAs UDP Echo Operation

This section contains the following example:

- Configuring a UDP Echo Operation: Example, page 12

Configuring a UDP Echo Operation: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to monitoring UDP echo operations using IP SLA.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs UDP Echo Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs UDP Echo Operation

Feature Name	Releases	Feature Information
IP SLAs UDP Jitter Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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)	12.2(33)SRC, 12.2(33)SB, 12.4(20)T	Support was added for operability in IPv6 networks.

IP SLAs—Analyzing IP Service Levels Using the HTTP Operation

First Published: August 14, 2006
Last Updated: March 13, 2009

This module describes how to use the Cisco IOS 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. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs HTTP Operation" section on page 18.

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

Contents

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Prerequisites for the IP SLAs HTTP Operation

Before configuring the IP SLAs HTTP operation you should be familiar with the *"Cisco IOS IP SLAs Overview"* chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs HTTP Operation

To perform the tasks required to monitor the performance of an HTTP server using IP SLA, you should understand the following concept:

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.

Note IP SLAs has individual Domain Name Server (DNS) and TCP Connect operations. For more details, see the "Where to Go Next" section on page 16.

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 the IP SLAs HTTP Operation

This section contains the following procedures:

Configuring and Scheduling an HTTP GET Operation on the Source Device

To measure the response time between a Cisco device and an HTTP server to retrieve a web page, use the IP SLAs HTTP operation. A GET request requires only a specified URL. This operation does not require the IP SLAs Responder to be enabled.

Perform one of the following tasks in this section, depending on whether you want to configure a basic HTTP GET operation or configure an HTTP GET operation with optional parameters:

Configuring and Scheduling a Basic HTTP GET Operation on the Source Device

Perform this task to enable an HTTP GET operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} **url** *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. **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	**http** {**get** | **raw**} **url** *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 url http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode. • Use the **get** keyword to specify an HTTP GET operation. • Use the **url** keyword and *url* argument to specify the URL of the destination HTTP server.
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	**exit** **Example:** `Router(config-ip-sla-http)# exit`	Exits HTTP 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.

Examples

The following example shows the configuration of an IP SLAs operation type of HTTP GET that will start immediately and run indefinitely. This operation will retrieve the home page from the www.cisco.com website.

```
ip sla 8
 http get url http://198.133.219.25
 frequency 90
!
ip sla schedule 8 life forever start-time now
```

Troubleshooting Tips

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

What to Do Next

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 an HTTP GET Operation with Optional Parameters on the Source Device

Perform this task to enable an HTTP GET operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} **url** *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. **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	**http** {**get** | **raw**} **url** *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 url http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode. • Use the **get** keyword to specify an HTTP GET operation. • Use the **url** keyword and *url* argument to specify the URL of the destination HTTP server. • Use the **name-server** keyword and *ip-address* argument to specify the IP address of the destination DNS. • Use the **version** keyword and *version-number* argument to specify the version number. • Use the optional **source-ipaddr** keyword and associated options to specify an IP address or designated IP name as the source of the HTTP operation. This is useful when IP SLAs packets are to be routed within an IPSec or GRE tunnel. • Use the optional **source-port** keyword and *port-number* argument to specify a source port number. • Use the optional **cache** keyword to specify that cached HTTP pages can be downloaded. Use the **disable** keyword when you want to disable the download of cached HTTP pages. This is enabled by default. • Use the optional **proxy** keyword and proxy-url argument to specify proxy information.
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.

	Command or Action	Purpose
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** **Example:** `Router(config-ip-sla-http)# http-raw-request`	(Optional) Explicitly specifies the options for a GET request for an IP SLAs HTTP operation.
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.

	Command or Action	Purpose
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	**exit** **Example:** `Router(config-ip-sla-http)# exit`	Exits HTTP 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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the HTTP GET operation number 8.

```
Router# show ip sla configuration 8

Complete Configuration Table (includes defaults)
Entry Number: 8
Owner:
Tag: FLL-LA
```

```
Type of Operation to Perform: http
Reaction and History Threshold (milliseconds): 5000
Operation Frequency (seconds): 90
Operation Timeout (milliseconds): 5000
Verify Data: FALSE
Status of Entry (SNMP RowStatus): active
Protocol Type: httpAppl
Target Address:
Source Address: 0.0.0.0
Target Port: 0
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: 0x0
HTTP Operation: get
HTTP Server Version: 1.0
URL: http://198.133.219.25
Proxy:
Raw String(s):

Cache Control: enabled
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

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

What to Do Next

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 an HTTP RAW Operation on the Source Device

To measure the response time between a Cisco device and an HTTP server to retrieve a web page, use the IP SLAs HTTP operation. To perform a RAW request, IP SLAs requires you to specify the entire contents of the HTTP request. After entering HTTP RAW configuration mode, you can specify HTTP 1.0 commands to complete the HTTP RAW request. This operation does not require the IP SLAs Responder to be enabled.

Perform this task to enable an HTTP RAW operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} **url** *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. **exit**
8. **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm*[:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*] [**ageout** *seconds*] [**recurring**]
9. **exit**
10. **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	**http** {**get** | **raw**} **url** *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 url http://198.133.219.25`	Defines an HTTP operation. • Use the **raw** keyword to specify an HTTP RAW operation. • Use the **url** keyword and *url* argument to specify the URL of the destination HTTP server. • Use the **name-server** keyword and *ip-address* argument to specify the IP address of the destination DNS. • Use the **version** keyword and *version-number* argument to specify the version number. • Use the optional **source-ipaddr** keyword and associated options to specify an IP address or designated IP name as the source of the HTTP operation. This is useful when IP SLAs packets are to be routed within an IPsec or GRE tunnel. • Use the optional **source-port** keyword and *port-number* argument to specify a source port number. • Use the optional **cache** keyword to specify that cached HTTP pages can be downloaded. Use the **disable** keyword when you want to disable the download of cached HTTP pages. This is enabled by default. • Use the optional **proxy** keyword and *proxy-url* argument to specify proxy information.
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	**exit** **Example:** `Router(config-ip-sla-http)# exit`	Exits HTTP RAW configuration submode and returns to global configuration mode.
Step 8	**ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm*[:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*] [**ageout** *seconds*] [**recurring**] **Example:** `Router(config)# ip sla schedule 5 start-time now life forever`	Configures the scheduling parameters for an individual IP SLAs operation.
Step 9	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 10	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the HTTP RAW operation number 8.

```
Router# show ip sla configuration 8

Complete Configuration Table (includes defaults)
Entry Number: 8
Owner:
Tag:
Type of Operation to Perform: http
Reaction and History Threshold (milliseconds): 5000
Operation Frequency (seconds): 90
Operation Timeout (milliseconds): 5000
Verify Data: FALSE
Status of Entry (SNMP RowStatus): active
Protocol Type: httpAppl
Target Address:
Source Address: 0.0.0.0
Target Port: 0
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: 0x0
HTTP Operation: raw
HTTP Server Version: 1.0
URL: http://198.133.219.25
Proxy:
Raw String(s):
GET /en/US/hmpgs/index.html HTTP/1.0\r\n\r\n

Cache Control: enabled
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

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

What to Do Next

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 the IP SLAs HTTP Operation

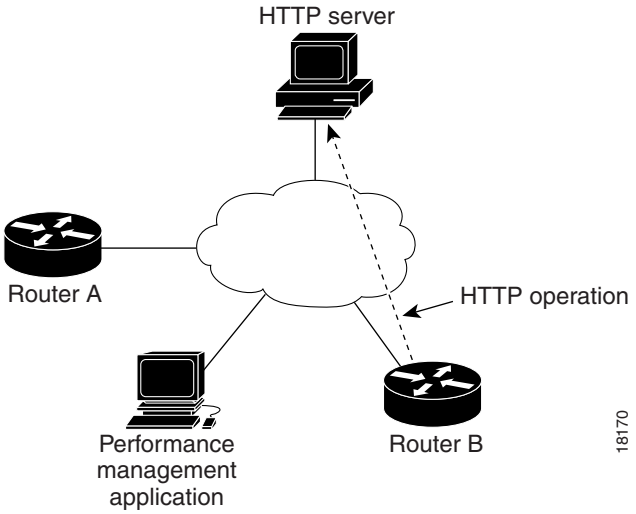
This section provides the following configuration examples:

- Configuring an HTTP GET Operation: Example, page 15
- Configuring an HTTP RAW Operation: Example, page 15
- Configuring an HTTP RAW Operation Through a Proxy Server: Example, page 15
- Configuring an HTTP RAW Operation with Authentication: Example, page 16

Configuring an HTTP GET Operation: Example

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. Figure 1 depicts the HTTP GET operation.

Figure 1 HTTP Operation



Router B Configuration

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

Configuring an HTTP RAW Operation: Example

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
```

Configuring an HTTP RAW Operation Through a Proxy Server: Example

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
```

Configuring an HTTP RAW Operation with Authentication: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to monitoring the performance of an HTTP server using IP SLA.

Related Documents

Related Topic	Document Title
Overview of Cisco IOS IP SLAs	"Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*
Cisco IOS IP SLAs commands: complete command syntax, defaults, command mode, command history, usage guidelines, and examples	*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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs HTTP Operation

Table 1 lists the features in this module and provides links to specific configuration information.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs HTTP Operation

Feature Name	Releases	Feature Information
IP SLAs HTTP Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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.

IP SLAs—Analyzing IP Service Levels Using the TCP Connect Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS 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. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs TCP Connect Operation" section on page 14.

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

Contents

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Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Prerequisites for the IP SLAs TCP Connect Operation

Before configuring the IP SLAs TCP Connect operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs TCP Connect Operation

To perform the tasks required to analyze TCP connection times using IP SLA, you should understand the following concept:

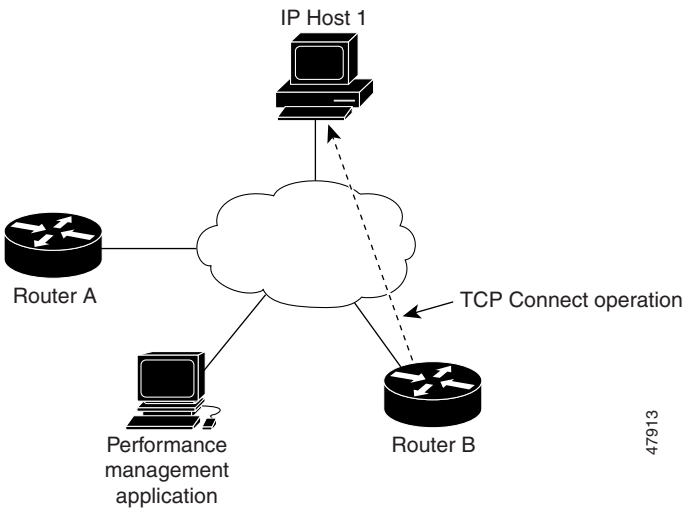
- TCP Connect Operation, page 2

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 Figure 1 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 1 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

This section contains the following procedures:

- Configuring the IP SLAs Responder on the Destination Device, page 3 (optional)
- Configuring and Scheduling a TCP Connect Operation on the Source Device, page 4 (required)

Configuring the IP SLAs Responder on the Destination Device

Perform this task to enable the IP SLAs Responder on the destination Cisco device of a TCP Connect operation. A TCP Connect operation measures the response time taken to perform a TCP Connect operation between a Cisco router and devices using IP.

Prerequisites

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. **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:** `Router(config)# ip sla responder`	Enables IP SLAs Responder functionality on a Cisco device.
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

To measure TCP connection response times between a Cisco IP device and a destination IP device, use the IP SLAs TCP Connect operation. A TCP Connect operation measures the response time taken to perform a TCP Connect operation between a Cisco router and devices using IP.

Perform one of the following tasks in this section, depending on whether you want to configure a basic TCP Connect operation or configure a TCP Connect operation with optional parameters:

- Configuring and Scheduling a Basic TCP Connect Operation on the Source Device, page 4
- Configuring and Scheduling a TCP Connect Operation with Optional Parameters on the Source Device, page 6

Prerequisites

If you are using the IP SLAs Responder, ensure that you have completed the "Configuring the IP SLAs Responder on the Destination Device" section on page 3 before you start this task.

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

Perform this task to enable a TCP Connect operation without any optional parameters.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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**}] **Example:** `Router(config-ip-sla)# tcp-connect 172.29.139.132 5000`	Defines a TCP Connect operation and enters IP SLA TCP configuration mode.
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.

	Command or Action	Purpose
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.

Examples

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
```

What to Do Next

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

Perform this task to enable a TCP Connect operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note The **tos** command defines the type of service (ToS) byte in the IPv4 header of an IP SLAs operation and is valid only in IPv4 networks. The **traffic-class** command defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

The **flow-label** command defines the value in the flow label field in the IPv6 header for a supported IP SLAs operation and is valid only in IPv6 networks.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **tos** *number*
    or
    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.

	Command or Action	Purpose
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.
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**} **Example:** `Router(config-ip-sla-tcp)# 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-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.

	Command or Action	Purpose
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.

Step 17	**tos** *number*
	or
	traffic-class *number*
	
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	or
	
	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.

	Command or Action	Purpose
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.

Examples

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

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

What to Do Next

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 the IP SLAs TCP Connect Operation

This section contains the following configuration example:

- Configuring a TCP Connect Operation: Examples, page 11

Configuring a TCP Connect Operation: Examples

The following example shows how to configure a TCP Connect operation as shown in Figure 1 from Router B to the Telnet port (TCP port 23) of IP Host 1 (IP address 10.0.0.1). The operation is scheduled to start immediately. In this example, the control protocol is disabled. 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
```

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs TCP Connect operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs TCP Connect Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs TCP Connect Operation

Feature Name	Releases	Feature Information
IP SLAs TCP Connect Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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)	12.2(33)SRC, 12.2(33)SB, 12.4(20)T	Support was added for operability in IPv6 networks.

IP SLAs—Analyzing IP Service Levels Using the ICMP Echo Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS 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. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs ICMP Echo Operation" section on page 13.

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

Contents

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Prerequisites for the IP SLAs ICMP Echo Operation

Before configuring the IP SLAs ICMP Echo operation you should be familiar with the *"Cisco IOS IP SLAs Overview"* chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Restrictions for the IP SLAs ICMP Echo Operation

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 the IP SLAs ICMP Echo Operation

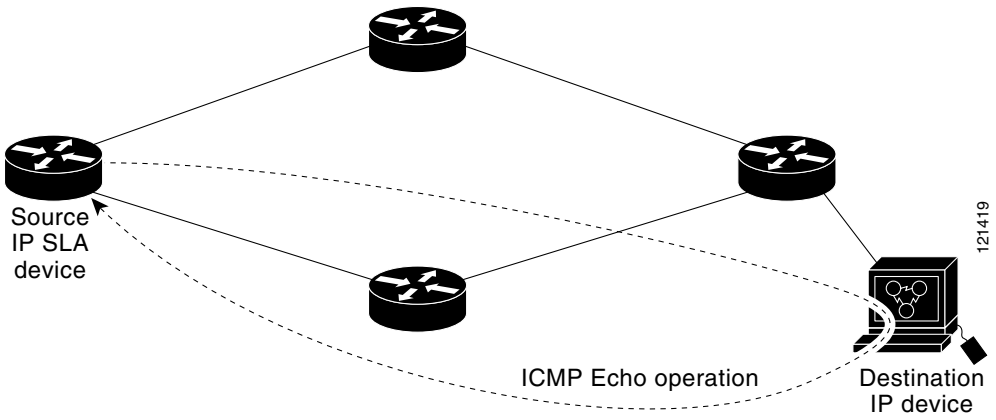
To perform the tasks required to analyze ICMP Echo performance using IP SLA, you should understand the following concept:

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 Figure 1 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 1 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 the IP SLAs ICMP Echo Operation

This section contains the following procedure:

- Configuring and Scheduling an ICMP Echo Operation, page 3 (required)

Configuring and Scheduling an ICMP Echo Operation

To monitor IP connections on a device, use the IP SLAs ICMP Echo operation. An ICMP Echo operation measures end-to-end response times between a Cisco router and devices using IP. ICMP Echo is useful for troubleshooting network connectivity issues. This operation does not require the IP SLAs Responder to be enabled.

Perform one of the following procedures in this section, depending on whether you want to configure and schedule a basic ICMP Echo operation or configure and schedule an ICMP Echo operation with optional parameters:

- Configuring and Scheduling a Basic ICMP Echo Operation on the Source Device, page 3
- Configuring and Scheduling an ICMP Echo Operation with Optional Parameters on the Source Device, page 5

Configuring and Scheduling a Basic ICMP Echo Operation on the Source Device

Perform this task to enable and schedule an ICMP Echo operation without any optional parameters.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **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	**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	**exit** **Example:** `Router(config-ip-sla-echo)# exit`	Exits IP SLA ICMP Echo configuration mode and returns to global configuration mode.

	Command or Action	Purpose
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 global configuration mode and returns to privileged EXEC mode.

Example

The following example shows the configuration of the IP SLAs ICMP Echo operation number 6 that will start immediately and run indefinitely.

```
ip sla 6
 icmp-echo 172.29.139.134 source-ip 172.29.139.132
 frequency 300
!
ip sla schedule 6 life forever start-time now
```

What to Do Next

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 an ICMP Echo Operation with Optional Parameters on the Source Device

Perform this task to enable an ICMP Echo operation on the source device and configure some optional IP SLAs parameters.

Note The **tos** command defines the type of service (ToS) byte in the IPv4 header of an IP SLAs operation and is valid only in IPv4 networks. The **traffic-class** command defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

The **flow-label** command defines the value in the flow label field in the IPv6 header for a supported IP SLAs operation and is valid only in IPv6 networks.

For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **tos** *number*
    or
    traffic-class *number*
19. **flow-label** *number*
20. **verify-data**
21. **vrf** *vrf-name*
22. **exit**
23. **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**]
24. **exit**
25. **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	**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.
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.

	Command or Action	Purpose
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	**tos** *number*
	or
	traffic-class *number*
	
	Example:
	`Router(config-ip-sla-jitter)# tos 160`
	or
	
	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 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.

	Command or Action	Purpose
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	**exit** **Example:** `Router(config-ip-sla-echo)# exit`	Exits ICMP Echo configuration submode and returns to global configuration mode.
Step 23	**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 24	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 25	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the ICMP Echo operation number 6.

```
Router# show ip sla configuration 6

Entry number: 6
Owner: jdoe
Tag: SFO-RO
Type of operation to perform: echo
Target address: 172.29.139.134
Source address: 172.29.139.132
Request size (ARR data portion): 28
Operation timeout (milliseconds): 2000
Type Of Service parameters: 160
Verify data: No
Vrf Name:
Operation frequency (seconds): 300
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): Forever
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
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
Enhanced History:
```

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

What to Do Next

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 the IP SLAs ICMP Echo Operation

This section contains the following configuration example:

- Configuring an ICMP Echo Operation: Example, page 10

Configuring an ICMP Echo Operation: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to monitoring IP connections using an IP SLAs ICMP Echo operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for the IP SLAs ICMP Echo Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs ICMP Echo Operation

Feature Name	Releases	Feature Information
IP SLAs ICMP Echo Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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)	12.2(33)SRC, 12.2(33)SB, 12.4(20)T	Support was added for operability in IPv6 networks.

IP SLAs—Analyzing IP Service Levels Using the ICMP Path Echo Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS 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. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs ICMP Path Echo Operation" section on page 14.

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

Contents

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Prerequisites for the IP SLAs ICMP Path Echo Operation

Before configuring the IP SLAs ICMP Path Echo operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Restrictions for the IP SLAs ICMP Path Echo Operation

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 the IP SLAs ICMP Path Echo Operation

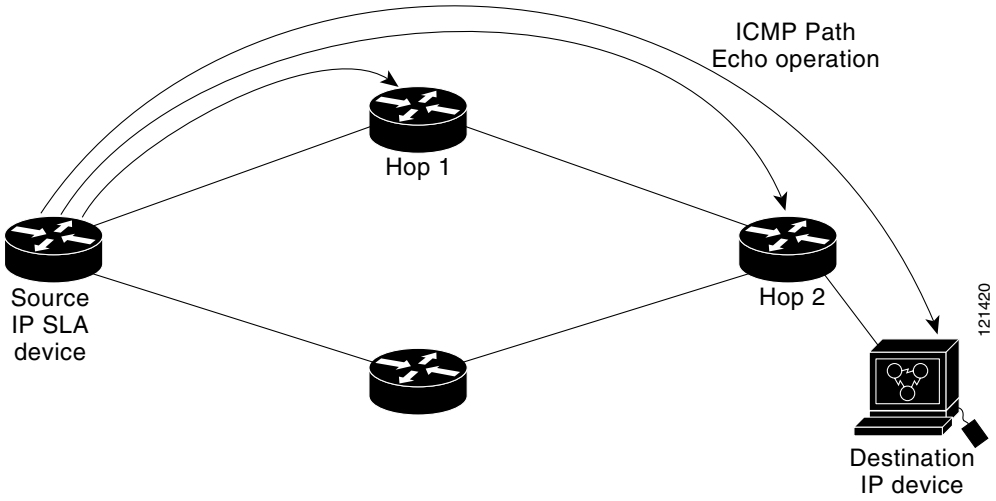
To perform the tasks required to monitor ICMP Path Echo performance using IP SLA, you should understand the following concept:

ICMP Path Echo Operation

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 Figure 1 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 1 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 the IP SLAs ICMP Path Echo Operation

This section contains the following procedure:

- Configuring and Scheduling an ICMP Path Echo Operation, page 3 (required)

Configuring and Scheduling an 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. This operation does not require the IP SLAs Responder to be enabled.

Perform one of the following procedures in this section, depending on whether you want to configure and schedule a basic ICMP Path Echo operation or configure and schedule an ICMP Path Echo operation with optional parameters:

- Configuring and Scheduling a Basic ICMP Path Echo Operation on the Source Device, page 3
- Configuring and Scheduling an ICMP Path Echo Operation with Optional Parameters on the Source Device, page 6

Configuring and Scheduling a Basic ICMP Path Echo Operation on the Source Device

Perform this task to enable and schedule an ICMP Path Echo operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **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-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* **Example:** `Router(config-ip-sla-pathEcho)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**exit** **Example:** `Router(config-ip-sla-pathEcho)# exit`	Exits IP SLA Path Echo configuration mode and returns to global configuration mode.
Step 7	**ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm*[:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*] [**ageout** *seconds*] [**recurring**] **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 global configuration mode and returns 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
```

What to Do Next

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

Perform this task to enable an ICMP Path Echo operation on the source device and configure some optional IP SLAs parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **exit**
24. **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**]
25. **exit**
26. **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	**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.

	Command or Action	Purpose
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.
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.

	Command or Action	Purpose
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* **Example:** `Router(config-ip-sla-pathEcho)# tos 160`	(Optional) Defines a type of service (ToS) byte in the IP header of an IP SLAs operation.
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	**exit** **Example:** `Router(config-ip-sla-pathEcho)# exit`	Exits Path Echo configuration submode and returns to global configuration mode.
Step 24	**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 25	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 26	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the ICMP Path Echo operation number 7.

```
Router# show ip sla configuration 7

Complete configuration Table (includes defaults)
Entry number: 7
Owner: jdoe
Tag: SGN-RO
Type of operation to perform: pathEcho
```

```
Target address: 172.29.139.134
Source address: 172.29.139.132
Request size (ARR data portion): 28
Operation timeout (milliseconds): 1000
Type Of Service parameters: 256
Verify data: No
Loose Source Routing: Disabled
Vrf Name:
LSR Path:
Operation frequency (seconds): 30
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): 300
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 paths kept: 5
Number of statistic hops kept: 16
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: 16
History Filter Type: None
```

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

What to Do Next

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 the IP SLAs ICMP Path Echo Operation

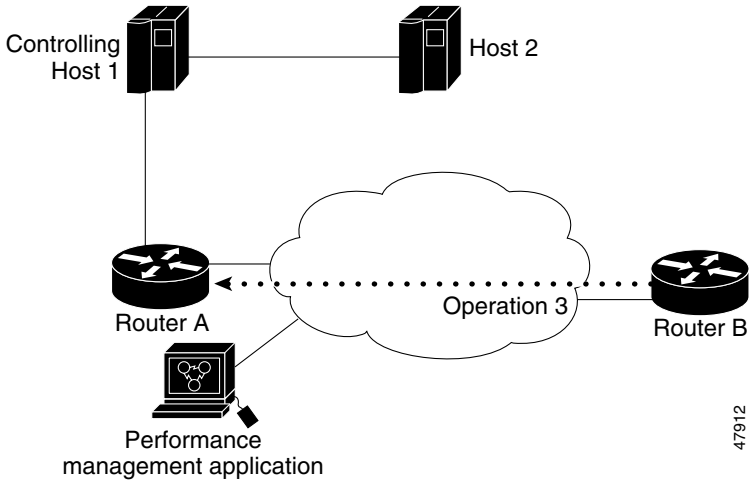
This section contains the following example:

- Configuring an ICMP Path Echo Operation: Example, page 12

Configuring an ICMP Path Echo Operation: Example

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. Figure 2 depicts the ICMP Path Echo operation.

Figure 2 ICMP Path Echo Operation



This example sets a Path Echo operation 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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to monitoring ICMP Path Echo operations using IP SLA.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs ICMP Path Echo Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

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Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs ICMP Path Echo Operation

Feature Name	Releases	Feature Information
IP SLAs ICMP Path Echo Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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.

IP SLAs—Analyzing IP Service Levels Using the ICMP Path Jitter Operation

First Published: August 14, 2006
Last Updated: February 9, 2009

This document describes how to use the Cisco IOS IP Service Level Agreements (SLAs) ICMP Path Jitter operation to monitor hop-by-hop jitter (inter-packet delay variance).

Cisco IOS IP SLAs is an embedded feature set in Cisco IOS software that allows you to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce occurrences of network congestion or outages. IP SLAs uses active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner—for measuring network performance. The accuracy of measured data is enhanced by enabling the IP SLAs responder, available in Cisco routers, on the destination device. This document also demonstrates how the data gathered using the Path Jitter operations can be displayed and analyzed using the Cisco IOS CLI.

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 for the IP SLAs ICMP Path Jitter Operation" section on page 11.

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

Contents

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Prerequisites

Before configuring the IP SLAs ICMP Path Jitter operation you should be familiar with the *"*Cisco IOS IP SLAs Overview*"* chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs ICMP Path Jitter Operation

To perform the tasks required to monitor ICMP Path Jitter performance using IP SLA, you should understand the following concept:

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 is not supported in the RTTMON MIB; configuration and performance data can only be obtained using the CLI.

How to Configure the IP SLAs ICMP Path Jitter Operation

This section contains the following procedure:

Configuring and Scheduling a ICMP Path Jitter Operation

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

Perform one of the following procedures in this section, depending on whether you want to configure and schedule a basic ICMP Path Jitter operation or configure and schedule an ICMP Jitter Operation with additional parameters.

- Configuring and Scheduling a Basic ICMP Path Jitter Operation, page 4
- Configuring and Scheduling an ICMP Path Jitter Operation with Additional Parameters, page 6

Restrictions

- 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.
- 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 the CLI, and statistics can only be returned using CLI **show ip sla** commands.

Note 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; see the *"*Cisco IOS IP SLAs Overview*"* chapter of the *Cisco IOS IP SLAs Configuration Guide*, for information about the IP SLAs Responder and the IP SLAs Control Protocol.

Note 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.

Configuring and Scheduling a Basic ICMP Path Jitter Operation

Perform the following steps to configure and schedule an ICMP Path Jitter operation using the general default characteristics for the operation. Start in privileged EXEC mode.

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. **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	**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	**exit** **Example:** `Router(config-ip-sla-pathJitter)# exit`	Exits path jitter configuration submode and returns to global configuration mode.

	Command or Action	Purpose
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 global configuration mode and returns to privileged EXEC mode.

Examples

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
```

What to Do Next

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 an ICMP Path Jitter Operation with Additional Parameters

Perform the following steps to configure and schedule an ICMP Path Jitter operation with additional parameters, using any of the optional commands needed. Start in Privileged Exec mode.

Restrictions

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. This means that the following IP SLAs commands are not supported for Jitter operations: **history buckets-kept**, **history filter**, **history lives-kept**, **samples-of-history-kept**, and **show ip sla history**.

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. **exit**
12. **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**]
13. **exit**
14. **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	**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	**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.

	Command or Action	Purpose
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	**exit** **Example:** `Router(config-ip-sla-pathJitter)# exit`	Exits Path Jitter configuration submode and returns to global configuration mode.
Step 12	**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 13	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 14	**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.

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**
- **lsr-path**
- **samples-of-history-kept**

- **history statistics-distribution-interval**
- **tos**
- **threshold**
- **verify-data**

Examples

In the following example, a Path Jitter operation is configured to run over a VPN using the VRF "red" to the CE at 10.3.30.130:

```
Router# configure terminal
Enter configuration commands, one per line.  End with the end command.
Router(config)# ip sla 7
Router(config-ip-sla)# path-jitter 10.3.30.130
Router(config-ip-sla-pathJitter)# vrf red
Router(config-ip-sla-pathJitter)# exit
Router(config)# ip sla schedule 7 start-time now life forever
```

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
```

Troubleshooting Tips

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

What to Do Next

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 the IP SLAs ICMP Path Jitter Operation

This section provides the following configuration example:

- Configuring a Path Jitter Operation: Example, page 9

Configuring a Path Jitter Operation: Example

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
```

Note 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 will only show the statistics for the first hop.

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to monitoring UDP echo operations using IP SLA.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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[1]	*RTP: A Transport Protocol for Real-Time Applications*; see the section "Estimating the Interarrival Jitter"

1. Support for the listed RFC is not claimed; listed as a reference only.

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs ICMP Path Jitter Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs ICMP Path Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs Path Jitter Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance).

IP SLAs—Analyzing IP Service Levels Using the FTP Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS IP Service Level Agreements (SLAs) FTP operation to measure the response time between a Cisco device and a File Transfer Protocol (FTP) server to retrieve a file. The IP SLAs FTP operation supports an FTP GET request only. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs FTP Operation" section on page 11.

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

Contents

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Prerequisites for the IP SLAs FTP Operation

Before configuring the IP SLAs FTP operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs FTP Operation

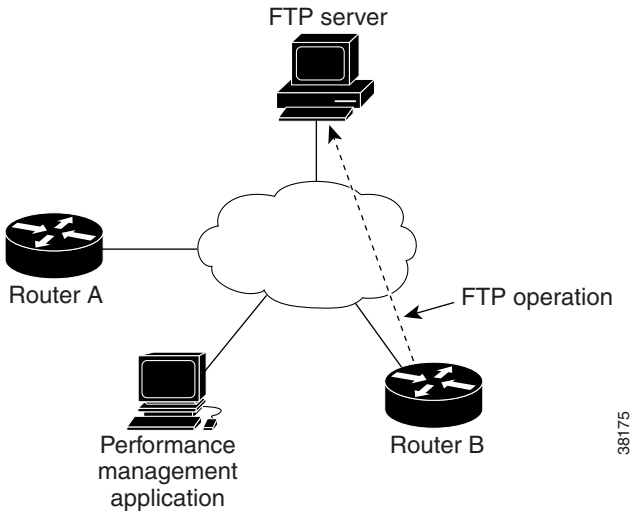
To perform the tasks required to analyze FTP server response times using IP SLA, you should understand the following concept:

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 Figure 1 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 1 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 the IP SLAs FTP Operation

This section contains the following procedure:

- Configuring and Scheduling an FTP Operation on the Source Device, page 3 (required)

Configuring and Scheduling an FTP Operation on the Source Device

To measure the response time between a Cisco device and an FTP server to retrieve a file, use the IP SLAs FTP operation. The IP SLAs FTP operation only supports FTP GET (download) requests. This operation does not require the IP SLAs Responder to be enabled so there are no tasks to be performed on the destination device.

Perform one of the following tasks in this section, depending on whether you want to configure a basic FTP operation or configure an FTP operation with optional parameters:

- Configuring and Scheduling a Basic FTP Operation on the Source Device, page 3
- Configuring and Scheduling an FTP Operation with Optional Parameters on the Source Device, page 6

Configuring and Scheduling a Basic FTP Operation on the Source Device

Perform this task to enable an FTP operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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

Examples

The following example shows the configuration of an IP SLAs operation type of FTP to retrieve a file named test.cap. The FTP operation number 10 is scheduled to start immediately and run indefinitely.

```
ip sla 10
 ftp get ftp://username:password@hostip/test.cap
```

```
 frequency 30
!
ip sla schedule 10 life forever start-time now
```

What to Do Next

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 an FTP Operation with Optional Parameters on the Source Device

Perform this task to enable an FTP operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **exit**
18. **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**]
19. **exit**
20. **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	**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* **Example:** `Router(config-ip-sla-ftp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
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	**exit** **Example:** `Router(config-ip-sla-ftp)# exit`	Exits FTP configuration submode and returns to global configuration mode.
Step 18	**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.

	Command or Action	Purpose
Step 19	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 20	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the FTP operation number 10.

```
Router# show ip sla configuration 10

Complete Configuration Table (includes defaults)
Entry number: 10
Owner: FTP-Test
Tag: FTP-Test
Type of operation to perform: ftp
Source address: 0.0.0.0
FTP URL: ftp://username:password@hostip/filename
Type Of Service parameters: 128
Operation timeout (milliseconds): 30000
Operation frequency (seconds): 30
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): Forever
Entry Ageout (seconds): never
Recurring (Starting Everyday): FALSE
Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 30000
Number of statistic hours kept: 2
Number of statistic distribution buckets kept: 1
Statistic distribution interval (milliseconds): 20
Number of history Lives kept: 0
Number of history Buckets kept: 15
```

Troubleshooting Tips

Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with the FTP operation.

What to Do Next

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 the IP SLAs FTP Operation

This section contains the following configuration example:

Configuring an FTP Operation: Example

The following example shows how to configure an FTP operation as shown in Figure 1 from Router B to the FTP server. 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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs FTP operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs FTP Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs FTP Operation

Feature Name	Releases	Feature Information
IP SLAs FTP Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS IP 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.

IP SLAs—Analyzing IP Service Levels Using the DNS Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS IP Service Level Agreements (SLAs) DNS operation to measure the difference between the time taken to send a Domain Name System (DNS) request and receive a reply. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. 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 for the IP SLAs DNS Operation" section on page 12.

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

Contents

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Prerequisites for the IP SLAs DNS Operation

Before configuring the IP SLAs DNS operation you should be familiar with the *"Cisco IOS IP SLAs Overview"* chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs DNS Operation

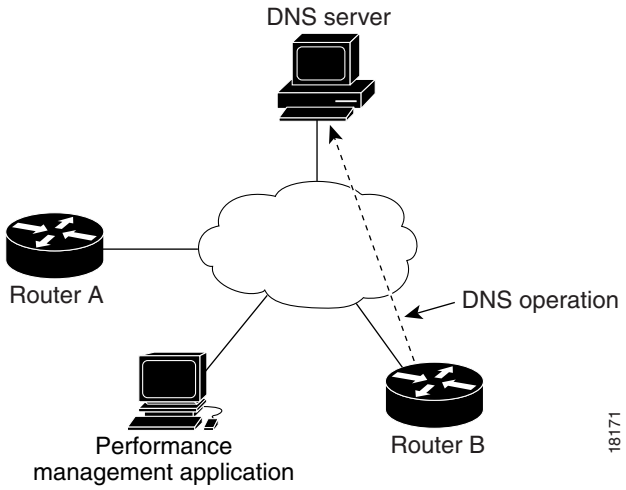
To perform the tasks required to analyze DNS lookup times using IP SLA, you should understand the following concept:

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 Figure 1 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 1 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 the IP SLAs DNS Operation

This section contains the following procedure:

- Configuring and Scheduling a DNS Operation on the Source Device, page 4 (required)

Configuring and Scheduling a DNS Operation on the Source Device

To measure the difference between the time taken to send a DNS request and the time a reply is received by a Cisco device, use the IP SLAs DNS operation. This operation does not require the IP SLAs Responder to be enabled so there are no tasks to be performed on the destination device.

Perform one of the following tasks in this section, depending on whether you want to configure a basic DNS operation or configure a DNS operation with optional parameters:

- Configuring and Scheduling a Basic DNS Operation on the Source Device, page 4
- Configuring and Scheduling a DNS Operation with Optional Parameters on the Source Device, page 6

Configuring and Scheduling a Basic DNS Operation on the Source Device

Perform this task to enable a DNS operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **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	**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	**exit** **Example:** `Router(config-ip-sla-dns)# exit`	Exits DNS 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 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 global configuration mode and returns to privileged EXEC mode.

Examples

The following example shows the configuration of an IP SLAs operation type of DNS to find the IP address of the hostname host1. The DNS operation number 11 is scheduled to start immediately and run indefinitely.

```
ip sla 11
 dns host1 name-server 172.20.2.132
 frequency 60
!
ip sla schedule 11 life forever start-time now
```

What to Do Next

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 DNS Operation with Optional Parameters on the Source Device

Perform this task to enable a DNS operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **exit**
18. **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**]
19. **exit**
20. **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	**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	**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.

	Command or Action	Purpose
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* **Example:** `Router(config-ip-sla-dns)# 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-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	**exit** **Example:** `Router(config-ip-sla-dns)# exit`	Exits DNS configuration submode and returns to global configuration mode.

	Command or Action	Purpose
Step 18	**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 19	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 20	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the DNS operation number 11.

```
Router# show ip sla configuration 11

Complete Configuration Table (includes defaults)
Entry number: 11
Owner: DNS-Test
Tag: DNS-Test
Type of operation to perform: dns
Target address: www.cisco.com
Source address: 0.0.0.0
Source port: 0
Operation timeout (milliseconds): 9000
Operation frequency (seconds): 60
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): Forever
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
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
```

Troubleshooting Tips

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

What to Do Next

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 the IP SLAs DNS Operation

This section contains the following configuration example:

- Configuring a DNS Operation: Example, page 10

Configuring a DNS Operation: Example

The following example shows how to configure a DNS operation as shown in Figure 1 from Router B to the DNS server (IP address 172.20.2.132). 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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs DNS operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs DNS Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs DNS Operation

Feature Name	Releases	Feature Information
IP SLAs DNS Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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.

IP SLAs—Analyzing IP Service Levels Using the DHCP Operation

First Published: August 14, 2006
Last Updated: July 16, 2008

This module describes how to use the Cisco IOS IP Service Level Agreements (SLAs) DHCP operation to measure the response time between a Cisco device and a Dynamic Host Control Protocol (DHCP) server to obtain an IP address. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. This module also demonstrates how the results of the DHCP operation can be displayed and analyzed to determine the DHCP response time within your network, or for a specific DHCP server. The DHCP operation can be used also for troubleshooting DHCP 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 for the IP SLAs DHCP Operation" section on page 11.

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

Contents

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Prerequisites for the IP SLAs DHCP Operation

Before configuring the IP SLAs DHCP operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs DHCP Operation

To perform the tasks required to analyze DHCP server response times using IP SLAs, you should understand the following concepts:

DHCP Operation

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

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, using the **ip dhcp-server** command, discovery packets are sent only to that DHCP server.

The DHCP operation also measures your DHCP server performance levels by determining the RTT taken to obtain a leased IP address.

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 the IP SLAs DHCP Operation

This section contains the following procedure:

- Configuring and Scheduling a DHCP Operation on the Source Device, page 3 (required)

Configuring and Scheduling a DHCP Operation on the Source Device

To measure the response time between a Cisco device and a DHCP server to lease an IP address, use the IP SLAs DHCP operation. This operation does not require the IP SLAs responder to be enabled so there are no tasks to be performed on the destination device.

Perform one of the following tasks in this section, depending on whether you want to configure a basic DHCP operation or configure a DHCP operation with optional parameters:

- Configuring and Scheduling a Basic DHCP Operation on the Source Device, page 3
- Configuring and Scheduling a DHCP Operation with Optional Parameters on the Source Device, page 5

Configuring and Scheduling a Basic DHCP Operation on the Source Device

Perform this task to enable a DHCP operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **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	**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	**exit** **Example:** `Router(config-ip-sla-dhcp)# exit`	Exits IP SLA DHCP 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.

What to Do Next

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 DHCP Operation with Optional Parameters on the Source Device

Perform this task to enable a DHCP operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

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. **exit**
18. **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**]
19. **exit**
20. **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	**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 option-82 circuit-id 10005A6F1234`	Defines a DHCP operation and enters IP SLA DHCP configuration mode.
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.

	Command or Action	Purpose
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* **Example:** `Router(config-ip-sla-dhcp)# 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-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	**exit** **Example:** `Router(config-ip-sla-dhcp)# exit`	Exits DHCP configuration submode and returns to global configuration mode.

	Command or Action	Purpose
Step 18	**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 19	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 20	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the DHCP operation number 12.

```
Router# show ip sla configuration 12

Complete Configuration Table (includes defaults)
Entry number: 12
Owner: DHCP-Test
Tag: DHCP-Test
Type of operation to perform: dhcp
Target address: 10.10.10.3
Source address: 0.0.0.0
Operation timeout (milliseconds): 5000
Dhcp option:
Operation frequency (seconds): 30
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): Forever
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
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
```

Troubleshooting Tips

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

What to Do Next

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 the IP SLAs DHCP Operation

This section contains the following configuration example:

- Configuring a DHCP Operation: Example, page 9

Configuring a DHCP Operation: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs DHCP operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs DHCP Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs DHCP Operation

Feature Name	Releases	Feature Information
IP SLAs DHCP Operation	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The Cisco IOS 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.

IP SLAs—Analyzing IP Service Levels Using the DLSw+ Operation

First Published: August 14, 2006
Last Updated: August 29, 2006

This module describes how to use the Cisco IOS IP Service Level Agreements (SLAs) DLSw+ operation to measure the Data Link Switching Plus (DLSw+) protocol stack and network response time between DLSw+ peers. IP SLAs is a portfolio of technology embedded in most devices that run Cisco IOS software, which 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. This module also demonstrates how the results of the DLSw+ operation can be displayed and analyzed to determine the DLSw+ peer tunnel response time.

Finding Feature Information in This Module

Your Cisco IOS software release may not support all of the features documented in this module. To reach links to specific feature documentation in this module and to see a list of the releases in which each feature is supported, use the "Feature Information for the IP SLAs DLSw+ Operation" section on page 12.

Finding Support Information for Platforms and Cisco IOS and Catalyst OS Software Images

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

Contents

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Prerequisites for the IP SLAs DLSw+ Operation

Before configuring the IP SLAs DLSw+ operation you should be familiar with the "Cisco IOS IP SLAs Overview" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Information About the IP SLAs DLSw+ Operation

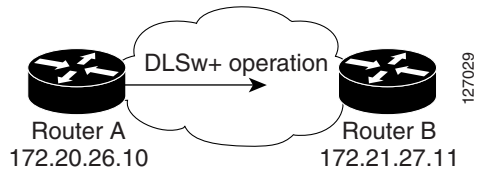
To perform the tasks required to analyze DLSw+ peer response times using IP SLA, you should understand the following concept:

DLSw+ Operation

The Cisco IOS IP SLAs DLSw+ operation measures the DLSw+ protocol stack and network response time between DLSw+ peers. DLSw+ is the enhanced Cisco version of RFC 1795. DLSw+ tunnels non-routable Layer 2 traffic such as Systems Network Architecture (SNA) traffic over IP backbones via TCP. The networking devices performing the tunneling of non-routable traffic into TCP/IP are referred to as DLSw+ peers. DLSw+ peers normally communicate through TCP port 2065. The destination networking device does not have to be a Cisco router if it supports RFC 1795.

In Figure 1, Router A is configured as the source IP SLAs device and a DLSw+ operation is configured with Router B as the remote DLSw+ peer. Router A and Router B are configured as connected DLSw+ peers. The peer (destination device) does not have to run a Cisco IOS IP SLA-capable image.

Figure 1 DLSw+ Operation



Network response time is computed by measuring the round-trip time (RTT) taken to connect to the remote DLSw+ peer using TCP. This operation does not use the IP SLAs Responder.

How to Configure the IP SLAs DLSw+ Operation

This section contains the following procedure:

Configuring and Scheduling a DLSw+ Operation on the Source Device

To measure the response time between a Cisco device and a DLSw+ peer, use the IP SLAs DLSw+ operation. This operation does not require the IP SLAs Responder to be enabled so there are no tasks to be performed on the destination device.

Perform one of the following tasks in this section, depending on whether you want to configure a basic DLSw+ operation or configure a DLSw+ operation with optional parameters:

- Configuring and Scheduling a Basic DLSw+ Operation on the Source Device, page 3
- Configuring and Scheduling a DLSw+ Operation with Optional Parameters on the Source Device, page 5

Configuring and Scheduling a Basic DLSw+ Operation on the Source Device

Perform this task to enable a DLSw+ operation without any optional parameters.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Prerequisites

Before enabling the IP SLAs DLSw+ operation you must configure a connected DLSw+ peer between the source and destination networking devices.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dlsw peer-ipaddr** *ip-address*
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	**dlsw peer-ipaddr** *ip-address* **Example:** `Router(config-ip-sla)# dlsw peer-ipaddr 172.21.27.11`	Defines a DLSw+ operation and enters IP SLA DLSw+ configuration mode.
Step 5	**frequency** *seconds* **Example:** `Router(config-ip-sla-dlsw)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**exit** **Example:** `Router(config-ip-sla-dlsw)# exit`	Exits IP SLA DLSw+ 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 global configuration mode and returns to privileged EXEC mode.

What to Do Next

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 DLSw+ Operation with Optional Parameters on the Source Device

Perform this task to enable a DLSw+ operation on the source device and configure some optional IP SLAs parameters. The source device is the location at which the measurement statistics are stored.

Note For information on scheduling a group of operations, see the "IP SLAs—Multioperation Scheduling of IP SLAs Operations" chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Prerequisites

Before enabling the IP SLAs DLSw+ operation you must configure a connected DLSw+ peer between the source and destination networking devices.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dlsw peer-ipaddr** *ip-address*
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. **exit**
19. **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**]
20. **exit**
21. **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	**dlsw peer-ipaddr** *ip-address* **Example:** `Router(config-ip-sla)# dlsw peer-ipaddr 172.21.27.11`	Defines a DLSw+ operation and enters IP SLA DLSw configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Router(config-ip-sla-dlsw)# 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-dlsw)# 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-dlsw)# 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-dlsw)# 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-dlsw)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Router(config-ip-sla-dlsw)# 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-dlsw)# 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-dlsw)# 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-dlsw)# 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-dlsw)# 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-dlsw)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 16	**threshold** *milliseconds* **Example:** `Router(config-ip-sla-dlsw)# 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-dlsw)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 18	**exit** **Example:** `Router(config-ip-sla-dlsw)# exit`	Exits DLSw configuration submode and returns to global configuration mode.

	Command or Action	Purpose
Step 19	**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 20	**exit** **Example:** `Router(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.
Step 21	**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.

Examples

The following sample output shows the configuration of all the IP SLAs parameters (including defaults) for the DLSw+ operation number 14.

```
Router# show ip sla configuration 14

Complete Configuration Table (includes defaults)
Entry number: 14
Owner:
Tag: DLSw-Test
Type of operation to perform: dlsw
Peer address: 172.21.27.11
Request size (ARR data portion): 0
Operation timeout (milliseconds): 50000
Operation frequency (seconds): 50
Next Scheduled Start Time: Start Time already passed
Group Scheduled: FALSE
Life (seconds): 50
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
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
```

Troubleshooting Tips

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

What to Do Next

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 the IP SLAs DLSw+ Operation

This section contains the following configuration example:

Configuring a DLSw+ Operation: Example

The following example shows how to configure a DLSw+ operation as shown in Figure 1 from Router A to Router B, a remote DLSw+ peer. Router B is configured as a DLSw+ peer and Router A is specified as the remote (connected) DLSw+ peer. Router A is then configured as a DLSw+ peer with Router B as the connected DLSw+ peer, and the IP SLAs DLSw+ operation parameters are configured. The operation is scheduled to start immediately and run for 7200 seconds (2 hours).

Router B Configuration

```
configure terminal
dlsw local-peer peer-id 172.21.27.11
dlsw remote-peer 0 tcp 172.20.26.10
```

Router A Configuration

```
dlsw local-peer peer-id 172.20.26.10
dlsw remote-peer 0 tcp 172.21.27.11
ip sla 14
 dlsw peer-ipaddr 172.21.27.11
 frequency 50
 timeout 50000
 tag DLSw-Test
 exit
ip sla schedule 14 life 7200 start-time now
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to the IP SLAs DLSw+ operation.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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 1795	Data Link Switching: Switch-to-Switch Protocol

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for the IP SLAs DLSw+ Operation

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for the IP SLAs DLSw+ Operation

Feature Name	Releases	Feature Information
IP SLAs DLSw+ Operation	12.3(14)T	The Cisco IOS IP SLAs Data Link Switching Plus (DLSw+) operation allows you to schedule and measure the DLSw+ protocol stack and network response time between DLSw+ peers

IP SLAs—Multioperation Scheduling of IP SLAs Operations

First Published: August 14, 2006
Last Updated: November 11, 2008

This document describes how to schedule multiple operations at once using the Cisco IOS IP Service Level Agreements (SLAs) group-scheduling feature.

Cisco IOS IP SLAs allows you to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce occurrences of network congestion or outages. IP SLAs uses active traffic monitoring—the generation of traffic in a continuous, reliable, and predictable manner with proactive notification capabilities—for measuring network performance. IP SLAs can be used for network troubleshooting, network assessment, and health monitoring.

The ability to schedule hundreds of operations at once allows service providers with large networks to monitor service levels for multiple environments.

In addition to allowing you to schedule multiple IP SLAs operations with a single command, IP SLAs can be used to schedule operations to run at equal intervals, automatically distributing the operations over a specified time frame. This distribution helps to minimize the CPU utilization, thereby enhancing the scalability of the IP SLAs monitoring solution.

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 for Multioperation Scheduling of IP SLAs Operations" section on page 17.

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

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Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Contents

Prerequisites for Multioperation Scheduling of IP SLAs Operations

- Configure the IP SLAs operations before group scheduling those operations.
- 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 Scheduling Multiple and Recurring IP SLAs Operations

To schedule IP SLAs as multiple or recurring operations, you should understand the following concept:

Scheduling of Multiple IP SLAs Operations

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 **ip sla group schedule** command. The following parameters can be configured with this command:

- 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 explain the IP SLAs multiple operations scheduling process:

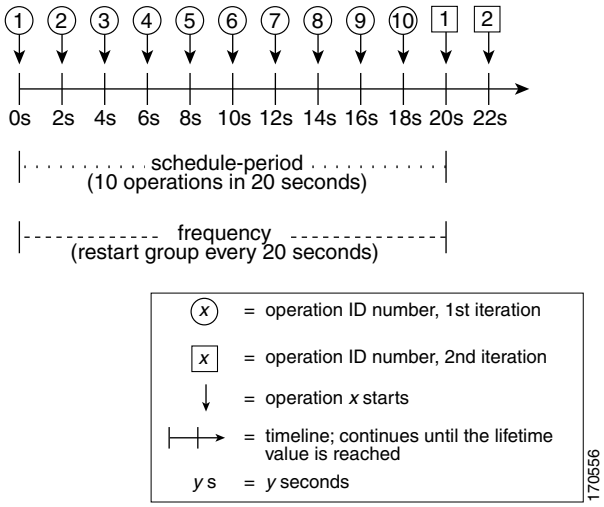
- Default Behavior of IP SLAs Multiple Operations Scheduling, page 4
- IP SLAs Multiple Operations Scheduling with Scheduling Period Less Than Frequency, page 4
- Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period, page 6
- IP SLAs Multiple Operations Scheduling with Scheduling Period Greater Than Frequency, page 7

Note The examples that follow focus on the interaction of the schedule period and frequency values, so the additional command syntax, such as start time and lifetime values, is not included in the illustrations.

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 using the **ip sla group schedule** command. In the example shown in Figure 1, the **ip sla group schedule 1 1-10 schedule-period 20 [frequency 20]** command is configured. This example schedules operation 1 to operation 10 within operation group 1. 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 Figure 1, configuring the frequency is optional because 20 is the default.

Figure 1 Schedule Period Equals Frequency—Default Behavior



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.

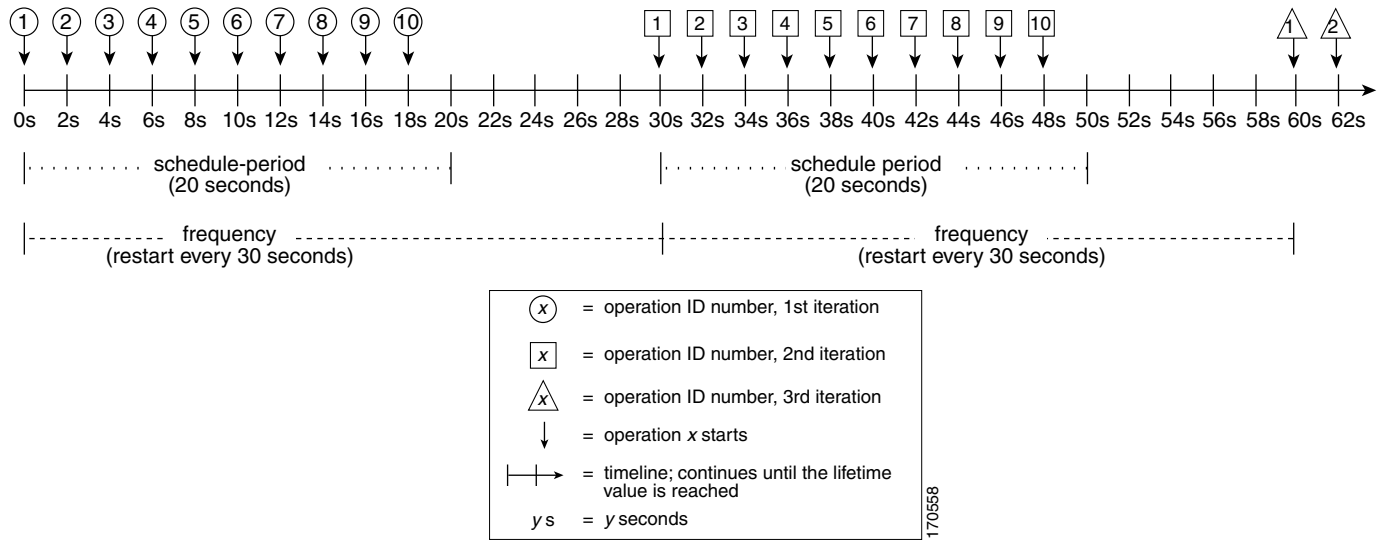
The frequency is the period of time that passes before the operation group is started again (repeated). If the frequency is not specified, the frequency is set to the value of the schedule period. In the example shown in Figure 1, operation group 1 will start again every 20 seconds. This configuration provides optimal division (spacing) of operations over the specified schedule period.

IP SLAs Multiple Operations Scheduling with Scheduling Period Less Than Frequency

As the frequency value in the **ip sla group schedule** configuration 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.

In the example shown in Figure 2, the **ip sla group schedule 1 1-10 schedule-period 20 frequency 30** command is configured. This example schedules 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 2 Schedule Period Is Less Than Frequency



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 shown in Figure 2, the following events occur when the **ip sla group schedule 1 1-10 schedule-period 20 frequency 30** command is configured:

- 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.

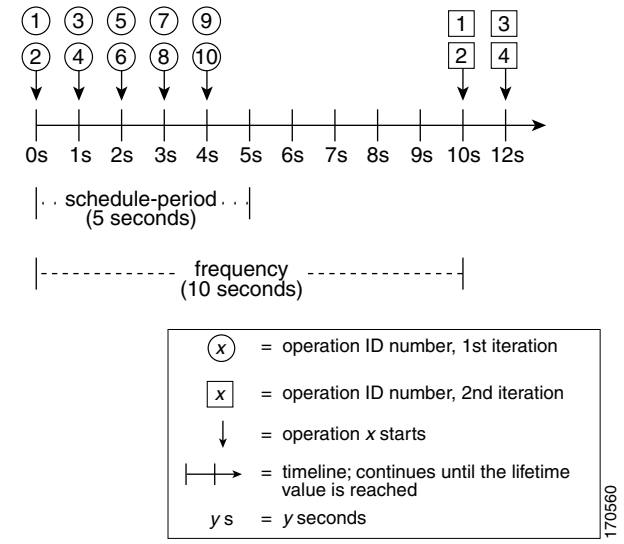
This process continues until the lifetime of operation group 2 ends. The lifetime can be configured using the **ip sla group schedule** command. The default lifetime for an operation group is forever.

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.

In the example shown in Figure 3, the **ip sla group schedule 3 1-10 schedule-period 5 frequency 10** command is configured. This example schedules 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 3 Number of IP SLAs Operations Is Greater Than the Schedule Period—Even Distribution



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 Figure 3, two operations will be started every 1 second.

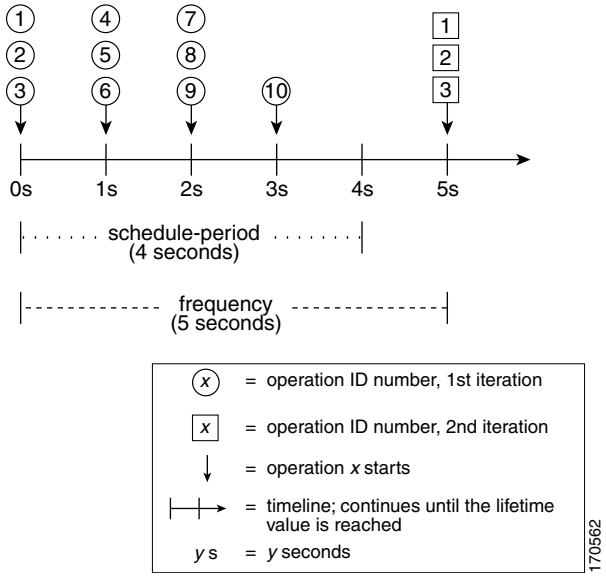
As the frequency is set to 10 in this example, each iteration of operation group 3 will start 10 seconds after the start of the previous iteration. However, this distribution is not optimal as there is a gap of 5 seconds (frequency minus schedule period) between the cycles.

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.

In the example shown in Figure 4, the **ip sla group schedule 4 1-10 schedule-period 4 frequency 5** command is configured. This example schedules 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 4 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



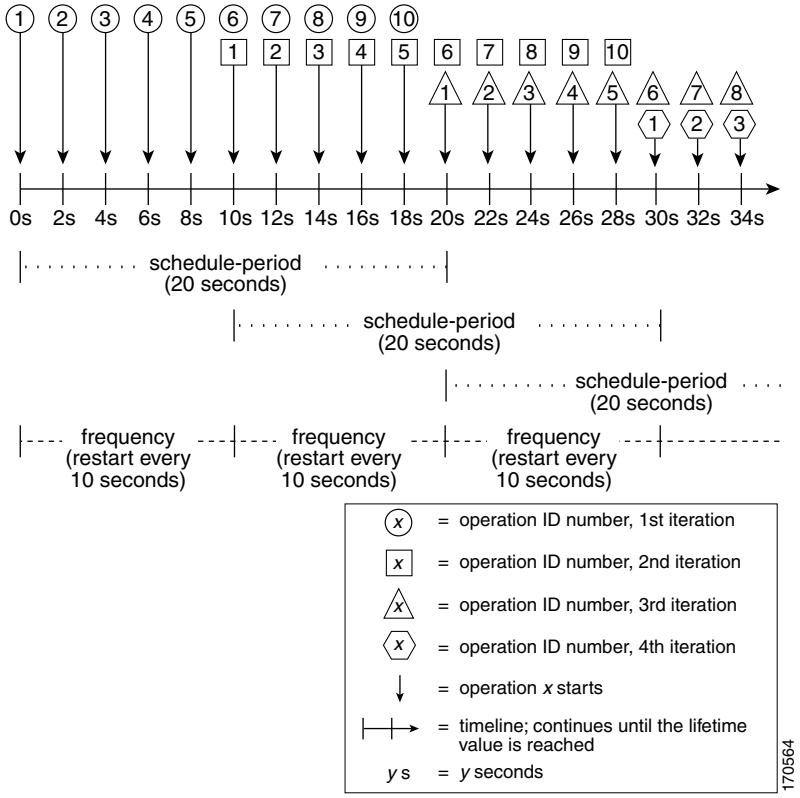
In this example, the IP SLAs multiple operations scheduling functionality calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 4 seconds, which equals 2.5 operations every 1 second). Since the number of operations does not equally divide into 1-second intervals, this number will be rounded off to the next whole number (see Figure 4) with the remaining operations to start at the last 1-second interval.

IP SLAs Multiple Operations Scheduling with Scheduling Period Greater Than Frequency

As the frequency value in the **ip sla group schedule** configuration 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.

In the example shown in Figure 5, the **ip sla group schedule 5 1-10 schedule-period 20 frequency 10** command is configured. This example schedules 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 5 IP SLAs Group Scheduling with Schedule Period Greater Than Frequency



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 Figure 5). 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 (see the Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period, page 6).

IP SLAs Random Scheduler

The IP SLAs Random Scheduler feature is an enhancement to the existing IP SLAs Multioperation Scheduling feature introduced in Cisco IOS Release 12.3(8)T. 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 the **ip sla group schedule** command 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 Schedule Multiple and Recurring IP SLAs Operations

This section contains the following tasks. Each task in the list is identified as either required or optional.

- Scheduling Multiple IP SLAs Operations, page 10 (required)
- Enabling the IP SLAs Random Scheduler, page 11 (optional)
- Verifying IP SLAs Multiple Operations Scheduling, page 12 (optional)

Scheduling Multiple IP SLAs Operations

Perform this task to schedule multiple IP SLAs operations using a single command.

Prerequisites

Before scheduling a group of operations, you should configure all the IP SLAs operations that will be used in that group. For information about configuring specific IP SLAs operation types, see the *Cisco IOS IP SLAs Features Roadmap*.

Restrictions

- The frequency of all operations scheduled in the operation group should be the same.
- The operation ID numbers are limited to a maximum of 125 characters. Do not give large integer values as operation ID numbers.

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.

	Command or Action	Purpose
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. • The *group-operation-number* argument identifies the IP SLAs operation ID to be group scheduled. • The *operation-id-numbers* argument specifies the number of operations that need to be group scheduled.
Step 4	**exit** **Example:** `Router(config)# exit`	Returns to the 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.

Enabling the IP SLAs Random Scheduler

Perform this task 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.

Prerequisites

Before scheduling a group of operations, you should configure all the IP SLAs operations that will be used in that group. For information about configuring specific IP SLAs operation types, see the *Cisco IOS IP SLAs Features Roadmap*.

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

Verifying IP SLAs Multiple Operations Scheduling

To verify and analyze the scheduled operation, use the **show ip sla statistics**, **show ip sla group schedule**, and **show ip sla configuration** commands.

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 above 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 Multioperation Scheduling of IP SLAs Operations

This section provides the following configuration examples:

- Scheduling Multiple IP SLAs Operations: Example, page 15
- Enabling the IP SLAs Random Scheduler: Example, page 15

Scheduling Multiple IP SLAs Operations: Example

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
```

Enabling the IP SLAs Random Scheduler: Example

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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to IP SLAs group scheduling.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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 website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for Multioperation Scheduling of IP SLAs Operations

Table 1 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 1 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 1 Feature Information for IP SLAs Multiple Operation Scheduling

Feature Name	Releases	Feature Information
IP SLAs Multioperation Scheduler	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for Cisco IOS IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command.
IP SLAs Random Scheduler	12.4(2)T, 12.2(33)SB, Cisco IOS XE Release 2.1, 12.2(33)SXI	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. The following sections provide information about this feature: • IP SLAs Random Scheduler, page 9 • Enabling the IP SLAs Random Scheduler, page 11 • Enabling the IP SLAs Random Scheduler: Example, page 15

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IP SLAs—Proactive Threshold Monitoring of IP SLAs Operations

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This document describes the proactive monitoring capabilities of Cisco IOS IP Service Level Agreements (SLAs) using thresholds and reaction triggering.

Cisco IOS IP SLAs allows you to monitor, analyze and verify IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce occurrences of network congestion or outages. IP SLAs uses active traffic monitoring for measuring network 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 for IP SLAs Proactive Threshold Monitoring" section on page 11.

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

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Information About Proactive Threshold Monitoring for IP SLAs

To perform the tasks required to configure proactive threshold monitoring using IP SLA, you should understand the following concepts:

IP SLAs Reaction Configuration

IP SLAs can be configured to react to certain measured network conditions. For example, if IP SLAs measures too much jitter on a connection, IP SLAs can generate a notification to a network management application, or trigger another IP SLAs operation to gather more data.

IP SLAs reaction configuration is performed using the **ip sla reaction-configuration** command. You can configure the **ip sla reaction-configuration** command multiple times so as to allow reactions for multiple monitored elements (for example, configuring thresholds for operation 1 for destination-to-source packet loss, and also configuring MOS thresholds for same operation). However, issuing the **no ip sla reaction-configuration** *operation-number* will clear all reactions for the specified operation. In other words, disabling of granular reaction elements (**no ip sla reaction-configuration** *operation-number* **react** *monitored-element*) is not currently supported, so as to provide backwards compatibility with the earlier version of this command.

You can check the configuration of the IP SLAs reaction configuration using the **show ip sla reaction-configuration** command.

IP SLAs Threshold Monitoring and Notifications

IP SLAs includes the capability for triggering SNMP notifications based on defined thresholds. This allows for proactive monitoring in an environment where IT departments can be alerted to potential network problems, rather than having to manually examine data.

IP SLAs supports threshold monitoring for performance parameters such as average jitter, unidirectional latency and bidirectional round trip time and connectivity. This proactive monitoring capability provides options for configuring reaction thresholds for important VoIP related parameters including unidirectional jitter, unidirectional packet loss, and unidirectional VoIP voice quality scoring (MOS scores).

IP SLAs can generate system logging (syslog) messages when a reaction condition occurs. These system logging messages can then be sent as SNMP notifications (traps) using the CISCO-RTTMON-MIB.

For packet loss and jitter, notifications can be generated for violations in either direction (source to destination and destination to source) or for round trip values. Packet loss, jitter and MOS statistics are specific to IP SLAs Jitter operations. Notifications can also be triggered for other events, such as round-trip-time violations, for most IP SLAs monitoring operations.

SNMP notifications (traps) for IP SLAs can be configured as a triggered action, to be sent when monitored values exceed an upper threshold or fall below a lower threshold, or when a set of defined conditions are met. For example, an SNMP trap can be triggered by 5 consecutive timeouts during an IP SLAs operation. The sending of SNMP traps is one of the options for triggered actions that can be configured for IP SLAs violations. The monitored values (also called monitored elements), the threshold type, and the triggered action are configured using the **ip sla reaction-configuration** global configuration mode command.

SNMP traps for IP SLAs are supported by the CISCO-RTTMON-MIB and CISCO-SYSLOG-MIB. Use the **ip sla logging traps** command to enable the generation of SNMP system logging messages specific to IP SLAs trap notifications. Use the **snmp-server enable traps rtr** command to enable the sending of IP SLAs SNMP trap notifications.

Note 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 Cisco IOS software: { emergency (0), alert (1), critical (2), error (3), warning (4), notice (5), informational (6), debugging (7) }.
This means that IP SLAs Threshold violations are logged as level 6 (informational) within the logging process, but are sent as level 7 (info) traps from the CISCO-SYSLOG-MIB.

How to Configure IP SLAs Reactions and Threshold Monitoring

IP SLAs Reactions are configured using the **ip sla reaction-configuration** command. The elements of this command are described in the following sections

Configuring Monitored Elements for IP SLAs Reactions

IP SLAs reactions are configured to be triggered when a monitored value exceeds or falls below a specified level, or when a monitored event (such as a timeout or connection loss) occurs. These monitored values and events are called monitored elements. Descriptions of some of the types of monitored elements available are described in the following sections:

You can configure the **ip sla reaction-configuration** command multiple times so as to allow reactions for multiple monitored elements (for example, configuring a threshold for operation 1 for destination-to-source packet loss, and also configuring a MOS threshold for the same operation). However, entering the **no ip sla reaction-configuration** *operation-number* command will clear all reactions for the specified operation (in other words, disabling of granular reaction elements is not currently supported, so as to provide backwards compatibility with the earlier version of this command).

Configuring Triggers for Round-Trip-Time Violations

Round-trip-time (rtt) is one of the monitored values of all IP SLAs operations. Events (such as traps) can be triggered when the rtt value rises above a specified threshold, or when it falls below a specified threshold. To configure rtt as the monitored element, use the following version of the **ip sla reaction-configuration** command:

Command or Action	Purpose
ip sla reaction-configuration *operation-number* **react rtt** [**threshold-type** *violation-condition*] **threshold-value** *upper-threshold lower-threshold* [**action-type** {**trapOnly** | **triggerOnly** | **trapAndTrigger**}] **Example:** `Router# ip sla reaction-configuration 10 react rtt threshold-type immediate threshold-value 5000 3000 action-type trapAndTrigger`	Configures an action (SNMP trap or IP SLAs trigger) to occur based on violations of thresholds for round-trip-time (rtt).

Configuring Triggers for Jitter Violations

Jitter (interpacket delay variance) is one of the monitored values of IP SLAs UDP Jitter operations. Jitter values are computed as source-to-destination, destination-to-source, and combined round-trip values. Events (such as traps) can be triggered when the average jitter value in either direction, or in both directions, rises above a specified threshold, or when it falls below a specified threshold.

Command or Action	Purpose
ip sla reaction-configuration *operation-number* **react** {**jitterAvg** | **jitterDSAvg** | **jitterSDAvg**} [**threshold-type** *violation-type*] **threshold-value** *upper-threshold lower-threshold* [**action-type** {**trapOnly** | **triggerOnly** | **trapAndTrigger**}] **Example:** `Router# ip sla reaction-configuration 10 react jitterAvg threshold-type immediate threshold-value 5000 3000 action-type trapAndTrigger`	Configures an action (SNMP trap or IP SLAs trigger) to occur based on violations of thresholds for average round-trip jitter values. • To configure the average source-to-destination jitter as the monitored element, use the **react jitterAvg** keyword combination. • To configure average destination-to-source jitter as the monitored element, use the **react jitterDSAvg** keyword combination. • To configure average round-trip jitter as the monitored element, use the **react jitterSDAvg** keyword combination.

Configuring Triggers for Packet Loss Violations

Packet loss is one of the monitored values of IP SLAs UDP Jitter operations. Jitter values are computed as source-to-destination and destination-to-source values. Events (such as traps) can be triggered when the jitter value in either direction rises above a specified threshold, or when it falls below a specified threshold.

To configure source-to-destination packet loss as the monitored element, use the **react PacketLossSD** syntax in the **ip sla reaction-configuration** command.

To configure destination-to-source jitter as the monitored element, use the **react PacketLossDS** syntax in the **ip sla reaction-configuration** command.

Configuring Triggers for Mean Opinion Score Violations

Mean opinion score (MOS) is one of the monitored values of IP SLAs Jitter VoIP operations. MOS values are computed as numbers to two decimal places, from a value of 1.00 (worst quality) to 5.00 (best quality). Events (such as traps) can be triggered when the MOS value in either direction rises above a specified threshold, or when it falls below a specified threshold.

To configure destination-to-source jitter as the monitored element, use the **react mos** syntax in the **ip sla reaction-configuration** command.

Configuring Threshold Violation Types for IP SLAs Reactions

The threshold-type syntax of the **ip sla reaction-configuration** command defines the type of threshold violation (or combination of threshold violations) that will trigger an event. Threshold violation types are as follows:

- immediate—Triggers an event immediately when the value for a reaction type (such as response time) exceeds the upper threshold value or falls below the lower threshold value, or when a timeout, connectionLoss, or verifyError event occurs.
- consecutive—Triggers an event only after a violation occurs a specified number of times consecutively. For example, the consecutive violation type could be used to configure an action to occur after a timeout occurs 5 times in a row, or when the round-trip-time exceeds the upper threshold value 5 times in a row.
- x of y—Triggers an event after some number (x) of violations within some other number (y) of probe operations (x of y).
- averaged—Triggers an event when the averaged totals of a value for x number of probe operations exceeds the specified upper-threshold value, or falls below the lower-threshold value.

Configuring these threshold violation types is described in the following sections.

Generating Events for Each Violation

To generate a trap (or trigger another operation) each time a specified condition is met, use the **immediate** threshold-type keyword:

ip sla reaction-configuration *operation-number* **react** *data-type* **threshold-type immediate threshold-value** *raising-value falling-value* **action-type** *action-value*

Generating Events for Consecutive Violations

To generate a trap (or trigger another operation) after a certain number (x) of consecutive violations, use the consecutive keyword with the optional number-of-occurrences argument:

ip sla reaction-configuration *operation-number* **react** *reaction-condition* **threshold-type consecutive** [*number-of-occurrences*] **threshold-value** *raising-value falling-value* **action-type** *action-value*

The default value for *number-of-occurrences* is 5.

Generating Events for x of y Violations

To generate a trap (or trigger another operation) after some number (x) of violations within some other number (y) of probe operations (x of y), use the **xofy** [*x-value y-value*] syntax:

ip sla reaction-configuration *operation-number* **react** *reaction-condition* **threshold-type xofy** *x-value y-value* **threshold-value** *raising-value falling-value* **action-type** *action-value*

The default x-value and y-value is 5 (**xofy 5 5**).

Generating Events for Averaged Violations

To generate a trap (or trigger another operation) when the averaged totals of x number of probe operations violate a falling-threshold or rising-threshold, use the **average** [*attempts*] syntax:

ip sla reaction-configuration *operation-number* **react** *reaction-condition* **threshold-type average** [*attempts*] **threshold-value** *raising-value falling-value* **action-type** *action-value*

The default value for *attempts* is 5.

Specifying Reaction Events

Action type options for the **ip sla reaction-configuration** command are as follows:

none—No action is taken.

trapOnly—Send an SNMP logging trap when the specified violation type occurs for the monitored element. IP SLAs logging traps are enabled using the **ip sla logging traps** command. For SNMP logging traps to be sent, SNMP logging must be enabled using the appropriate SNMP commands, including the **snmp-server enable traps syslog** command.

triggerOnly—Have one or more target operation's operational state make the transition from "pending" to "active" when the violation conditions are met. The target operations to be triggered are specified using the **ip sla reaction-trigger** command. A target operation will continue until its life expires, as specified by the target operation's configured lifetime value). A triggered target operation must finish its life before it can be triggered again.

trapAndTrigger—Trigger both an SNMP trap and start another IP SLAs operation when the violation conditions are met, as defined in the trapOnly and triggerOnly options above.

Configuration Examples for Proactive Threshold Monitoring Using IP SLA

This section contains the following configuration examples:

Configuring an IP SLAs Reaction Configuration: Example

In the following example, IP SLAs operation 10 (a UDP Jitter operation) is configured to send an SNMP logging trap when the MOS value exceeds 4.9 (best quality) of 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 settings for the **ip sla reaction-configuration** command when none of the optional syntax is used:

```
Router# show ip sla reaction-configuration 1

Entry number: 1
Reaction Configuration 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
```

Verifying an IP SLAs Reaction Configuration: Example

In the following example, multiple monitored elements (indicated by the `Reaction:` value) are configured for a single IP SLAs operation:

```
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
```

Table 1 describes the significant fields shown in this output.

Table 1 show ip sla reaction-configuration Field Descriptions

Field	Description
Reaction	The configured monitored element for IP SLAs reactions. Corresponds to the **react** { **connectionLoss** | **jitterAvg** | **jitterDSAvg** | **jitterSDAvg** | **mos** | **PacketLossDS** | **PacketLossSD** | **rtt** | **timeout** | **verifyError** } syntax in the **ip sla reaction-configuration** command.
Threshold type	The configured threshold type. Corresponds to the **threshold-type** { **never** | **immediate** | **consecutive** | **xofy** | **average** } syntax in the **ip sla reaction-configuration** command.
Rising (milliseconds)	The *upper-threshold* value, as configured by the **threshold-value** *upper-threshold lower-threshold* syntax in the **ip sla reaction-configuration** command.
Threshold Falling (milliseconds)	The *lower-threshold* value, as configured by the **threshold-value** *upper-threshold lower-threshold* syntax in the **ip sla reaction-configuration** command.
Threshold Count	The *x-value* in the **xofy** threshold-type, or the *number-of-probes* value for **average** threshold-type.
Threshold Count2	The *y-value* in the **xofy** threshold-type.
Action Type	The reaction to be performed when the violation conditions are met, as configured by the **action-type** { **none** | **trapOnly** | **triggerOnly** | **trapAndTrigger** } syntax in the **ip sla reaction-configuration** command.

Triggering SNMP Notifications: Example

In the following example, CISCO-SYSLOG-MIB traps will be sent to the remote host at 209.165.202.129 if the threshold values for round-trip-time (rtt) or VoIP mean opinion score (MOS) are violated:

```
Router(config)# ip sla 1
Router(config-ip-sla)# udp-jitter 209.165.200.225 3000 codec g711alaw
Router(config-ip-sla-jitter)# default frequency
Router(config-ip-sla-jitter)# exit

Router(config)# ip sla schedule 1 start now life forever
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
Router(config)#
Router(config)# snmp-server host 209.165.202.129 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
```

As shown in the following example, the IP SLAs Threshold violations are generated as level 6 (informational) in the Cisco IOS system logging process:

```
3d18h:%RTT-6-SAATHRESHOLD:RTR(11):Threshold exceeded for MOS
```

but are sent as level 7 (info) notifications from the CISCO-SYSLOG-MIB:

```
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
```

Where to Go Next

For information about other types of IP SLAs operations and IP SLAs features, see the *Cisco IOS IP SLAs Features Roadmap*.

Additional References

The following sections provide references related to configuring Cisco IOS IP SLAs.

Related Documents

Related Topic	Document Title
Cisco IOS IP SLAs command-line interface enhancements	*Cisco IOS IP Service Level Agreements Command Line Interface*, Cisco white paper
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	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
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Feature Information for IP SLAs Proactive Threshold Monitoring

Table 2 lists the release history for this feature.

Not all commands may be available in your Cisco IOS software release. For release information about a specific command, see the command reference documentation.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which Cisco IOS and Catalyst OS software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Note Table 2 lists only the Cisco IOS software release that introduced support for a given feature in a given Cisco IOS software release train. Unless noted otherwise, subsequent releases of that Cisco IOS software release train also support that feature.

Table 2 Feature Information for IP SLAs Proactive Threshold Monitoring

Feature Name	Releases	Feature Information
IP SLAs Reaction Threshold	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	Cisco IOS 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	12.3(14)T, 12.2(31)SB2, 12.2(33)SRB1, 12.2(33)SXH, Cisco IOS XE Release 2.1	Cisco IOS IP SLAs VoIP proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions.