Cisco IOS IP SLAs Overview

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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 Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

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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 originated from the technology previously known as Service Assurance Agent (SAA). 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 are monitored within the Cisco device and stored in both CLI and SNMP MIBs. The packets have configurable IP and application layer options such as source and destination IP address, User Datagram Protocol (UDP)/TCP port numbers, a type of service (ToS) byte (including Differentiated Services Code Point [DSCP] and IP Prefix bits), Virtual Private Network (VPN) routing/forwarding instance (VRF), and URL web address.

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. Cisco IOS IP SLAs collects a unique subset of the following performance metrics:

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

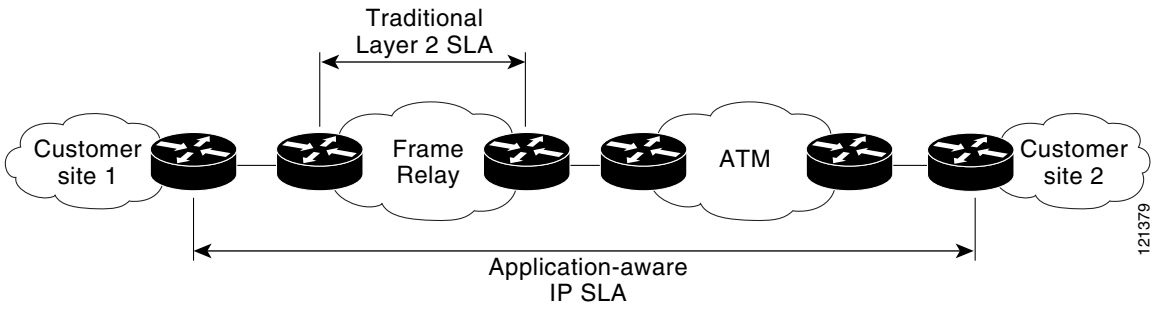
SNMP notifications based on the data gathered by an Cisco IOS IP SLAs operation allow the router to receive alerts when performance drops below a specified level and when problems are corrected. Cisco IOS IP SLAs uses the Cisco RTTMON MIB for interaction between external Network Management System (NMS) 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.
- Accuracy—Applications that are sensitive to slight changes in network performance require the precision of the sub-millisecond measurement of Cisco IOS IP SLAs.
- 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

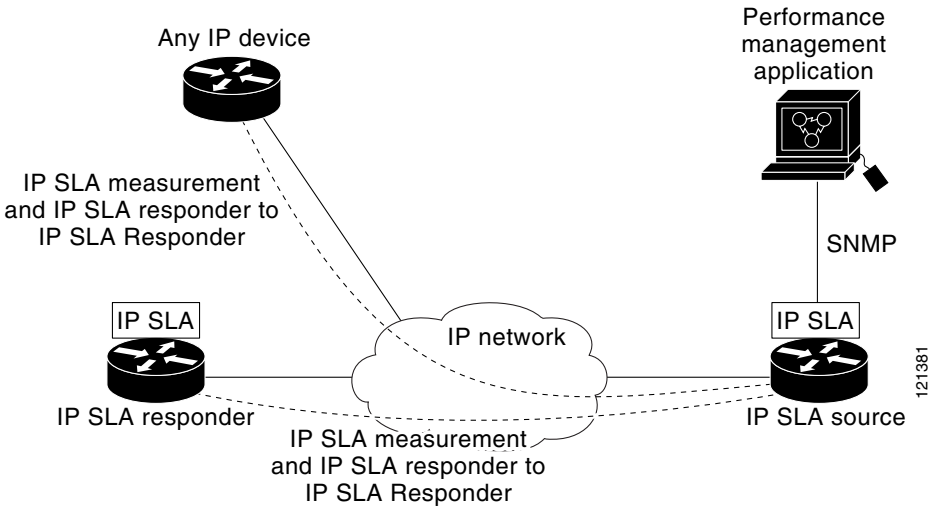
  - Provides proactive verification and connectivity testing of network resources (for example, indicates the network availability of an NFS server used to store business critical data from a remote site).
- Troubleshooting of network operation
  - Provides consistent, reliable measurement that immediately identifies problems and saves troubleshooting time.
- Voice over IP (VoIP) performance monitoring
- Multiprotocol Label Switching (MPLS) 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 is contained in this document. For configuration details and information about options for each operation type and how to display and interpret the operation results, see the individual Cisco IOS IP SLAs operation-specific chapters. The "Where to Go Next" section on page 9 provides links to each individual Cisco IOS IP SLAs operation-specific chapter.

Cisco IOS IP SLAs Operation Types

Table 1 shows the various types of Cisco IOS IP SLAs operations, what each operation measures, and for what purpose the operation is used. Most of the operations are described in more detail with configuration tasks and examples in other chapters. For links to these chapters, see the "Where to Go Next" section on page 9.

Table 1 Types of Cisco IOS IP SLAs Operation

Cisco IOS IP SLAs Operation	Measurements	Key Monitoring Application
UDP Jitter[1]	Measures round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity testing of networks that carry UDP traffic, such as voice. **Note** One-way delay requires time synchronization between source and target routers.	• Voice and data network performance • General IP performance **Note** This is the most commonly used Cisco IOS IP SLAs operation.
ICMP Path Jitter	Measures hop-by-hop jitter, packet loss, and delay measurement statistics in an IP network.	• Voice and data network performance • General IP performance
UDP Jitter for VoIP	Measures round-trip delay, one-way delay, one-way jitter, and one-way packet loss for VoIP traffic. Codec simulation G.711 u-law, G.711 a-law, and G.729A. MOS and ICPIF voice quality scoring capability. **Note** One-way delay requires time synchronization between source and target routers.	• VoIP network and performance
UDP Echo[2]	Measures round-trip delay of UDP traffic.	• Server and IP application performance • Connectivity testing
ICMP Echo[3]	Measures round-trip delay for the full path.	• IP performance • Connectivity measurement

Table 1 Types of Cisco IOS IP SLAs Operation (continued)

Cisco IOS IP SLAs Operation	Measurements	Key Monitoring Application
ICMP Path Echo[4]	Measures round-trip delay and hop-by-hop round-trip delay.	• Connectivity measurement • Identify bottlenecks in the path
HTTP	Measures round-trip time to retrieve a web page.	• Web server performance
TCP Connect	Measures the time taken to connect to a target device with TCP.	• Server and application performance
FTP	Measures round-trip time to transfer a file.	• FTP server performance
Dynamic Host Configuration Protocol (DHCP)	Measures round-trip time to get an IP address from a DHCP server.	• DHCP server response time
Domain Name System (DNS)	Measures DNS lookup time.	• Web or DNS server performance
Data Link Switching Plus (DLSw+)	Measures peer tunnel response time.	• Response time between DLSw+ peers
Frame Relay	Measures circuit availability, round-trip delay, and frame delivery ratio. **Note** This operation does not have SNMP support.	• WAN service level agreement performance

1. Cisco IOS IP SLAs has the capability to make a UDP Jitter operation run within a specific Layer 3 MPLS VPN.
2. Cisco IOS IP SLAs has the capability to make a UDP Echo operation run within a specific Layer 3 MPLS VPN.
3. Cisco IOS IP SLAs has the capability to make an ICMP Echo operation run within a specific Layer 3 MPLS VPN.
4. Cisco IOS IP SLAs has the capability to make an ICMP Path Echo operation run within a specific Layer 3 MPLS VPN.

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.

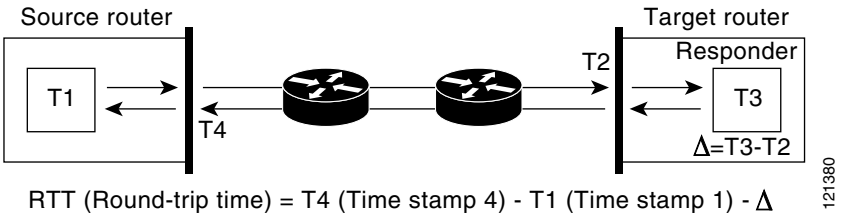
Response Time Computation for Cisco IOS IP SLAs

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. This time stamping is made with a granularity of sub-millisecond (ms). At times of high network activity, an ICMP ping test often shows a long and inaccurate response time, while an 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 an 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—Multiple Operation Scheduling" chapter of the *Cisco IOS IP SLAs Configuration Guide*, Release 12.4.

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, an 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" chapter of the *Cisco IOS IP SLAs Configuration Guide*, Release 12.4.

Where to Go Next

- To implement the UDP Jitter operation, proceed to the "IP SLAs—Analyzing IP Service Levels Using the UDP Jitter Operation" chapter.
- To implement the UDP Jitter operation for VoIP applications, proceed to the "IP SLAs—Analyzing Service Levels Using the VoIP UDP Jitter Operation" chapter.
- To implement the VoIP Gatekeeper Registration Delay operation, proceed to the "IP SLAs VoIP Gatekeeper Registration Delay Monitoring" chapter.

- To implement the VoIP Call Setup operation, proceed to the "IP SLAs VoIP Call Setup (Post-Dial Delay) Monitoring" chapter.
- To implement the UDP Echo operation, see the "IP SLAs—Analyzing IP Service Levels Using the UDP Echo Operation" chapter.
- To implement the HTTP operation, see the "IP SLAs—Analyzing IP Service Levels Using the HTTP Operation" chapter.
- To implement the TCP Connect operation, see the "IP SLAs—Analyzing IP Service Levels Using the TCP Connect Operation" chapter.
- To implement the ICMP Echo operation, see the "IP SLAs—Analyzing IP Service Levels Using the ICMP Echo Operation" chapter.
- To implement the ICMP Path Echo operation, see the "IP SLAs—Analyzing IP Service Levels Using the ICMP Path Echo Operation" chapter.
- To implement the ICMP Path Jitter operation, proceed to the "IP SLAs—Analyzing IP Service Levels Using the ICMP Path Jitter Operation" chapter.
- To implement the FTP operation, see the "IP SLAs—Analyzing IP Service Levels Using the FTP Operation" chapter.
- To implement the DNS Connect operation, see the "IP SLAs—Analyzing IP Service Levels Using the DNS Operation" chapter.
- To implement the DHCP operation, see the "IP SLAs—Analyzing IP Service Levels Using the DHCP Operation" chapter.
- To implement the DLSW+ operation, see the "IP SLAs—Analyzing IP Service Levels Using the DLSW+ Operation" chapter.
- For details about the IP SLAs multiple operations scheduling functionality, see the "IP SLAs—Multiple Operation Scheduling" chapter.
- For details on using thresholds with IP SLAs operations, see the "IP SLAs—Proactive Threshold Monitoring" chapter.

Additional References

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

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*, Release 12.4
Cisco IOS IP SLAs commands: complete command syntax, defaults, command mode, command history, usage guidelines, and examples	*Cisco IOS IP SLAs Command Reference*, Release 12.4

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
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