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 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 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 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. For details about network management products that use Cisco IOS IP SLAs, see http://www.cisco.com/go/ipsla.

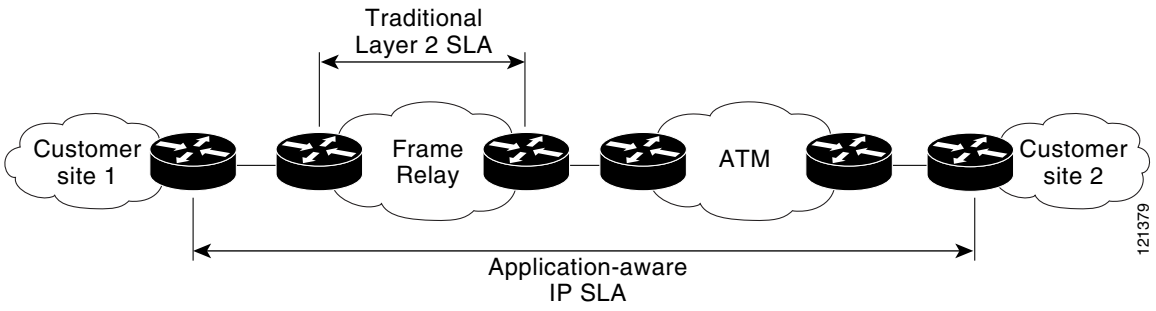
SNMP notifications based on the data gathered by a Cisco IOS IP SLAs operation allow the router to receive alerts when performance drops below a specified level and when problems are corrected. Cisco IOS IP SLAs uses the Cisco RTTMON MIB for interaction between external Network Management System (NMS) 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

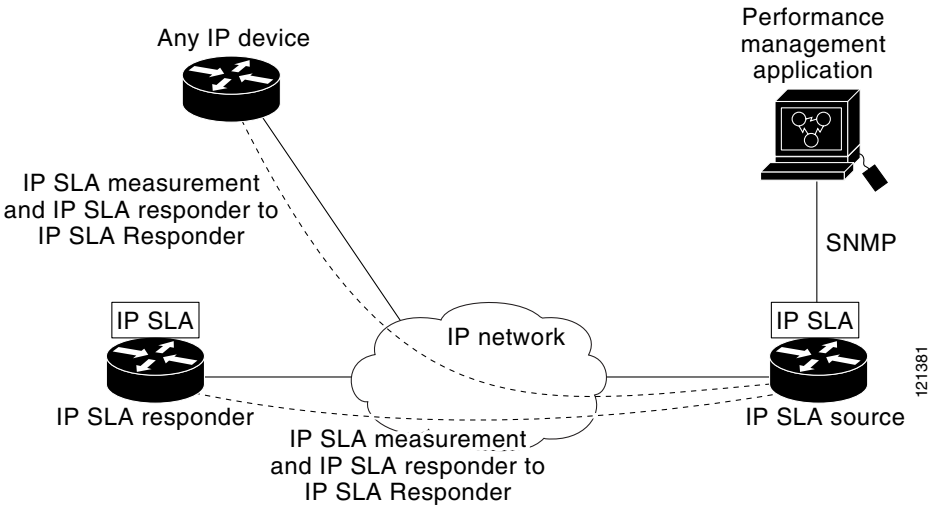
- Cisco IOS IP SLAs monitoring
  - Provides service level agreement monitoring, measurement, and verification.
- Network performance monitoring
  - Measures the jitter, latency, or packet loss in the network.
  - Provides continuous, reliable, and predictable measurements.
- IP service network health 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

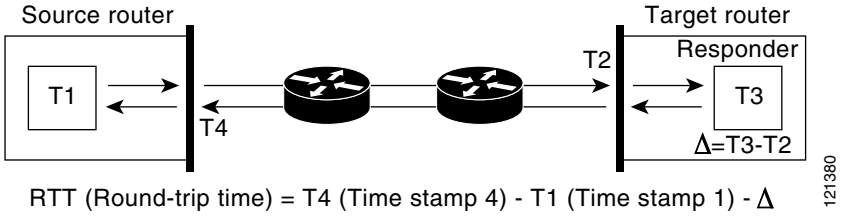
Routers may take tens of milliseconds to process incoming packets, due to other high-priority processes. This delay affects the response times because the reply to test packets might be sitting on queue while waiting to be processed. In this situation, the response times would not accurately represent 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" module 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" module 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.

History Statistics

Cisco IOS IP SLAs maintains the following three types of history statistics:

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

- Distribution statistics—IP SLAs maintains a frequency distribution over configurable intervals. Each time IP SLAs starts an operation, a new history bucket is created until the number of history buckets matches the specified size or the lifetime of the operation expires. By default, the history for an IP SLAs operation is not collected. If history is collected, each bucket contains one or more history entries from the operation. History buckets do not wrap.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
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 and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html