WHITE PAPER

CISCO IOS IP SERVICE LEVEL AGREEMENTS

Successfully delivering mission critical, performance sensitive services and applications.

INTRODUCTION

In response to escalating performance requirements for critical applications, converged IP networks must become optimized for performance levels. Service Level Agreements (SLAs) that support application solutions are becoming an increasingly common requirement, and SLAs in the IP infrastructure are an essential part of optimizing the network for business.

Network equipment must therefore verify service guarantees, validate network performance, improve network reliability, proactively identify network issues, and react to performance metrics with changes to the configuration and network. Cisco IOS® IP Service Level Agreements (SLAs) fulfills those needs, creating a network that is “performance-aware”.

This white paper illustrates the importance of monitoring both end-to-end IP Service levels and those at the IP layer, in order to provide true application-awareness. With Cisco IOS IP SLAs, Cisco has taken the traditional concept of Layer 2 SLAs, while advancing the IP infrastructure to become ‘application-aware’.

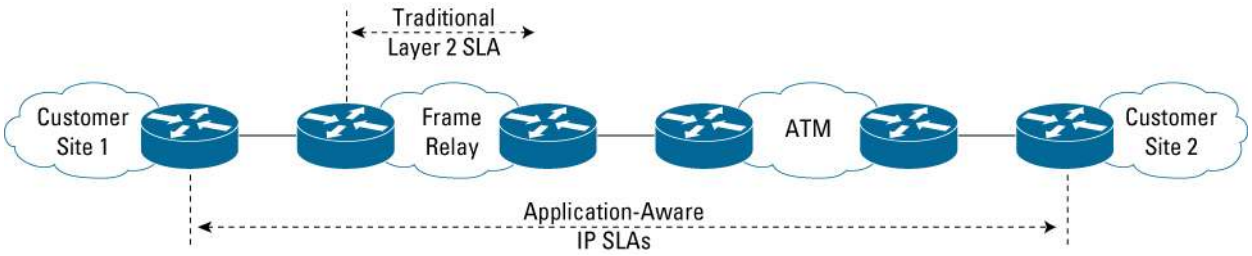
Enterprises depend heavily on Cisco IOS IP SLAs in order to meet their business objectives. “At DuPont, we use Cisco IOS IP SLAs to verify our outsourced Service Provider SLAs. The technology allows us to understand their delivered network performance, and helps us to negotiate cost-effective SLAs with Service Providers,” said Mike Dowler, Global Services Integration Manager, DuPont Telecommunications.

INCREASING IMPORTANCE OF SLAS

Traditional SLAs

Layer 2 circuit-switched networks are the basis of traditional SLAs. These networks must meet a Committed Information Rate (CIR), or minimal guaranteed bandwidth, as well as a minimum guaranteed connectivity rate, which is expressed as a percentage (ie: 99.9%). This SLA is a fixed circuit and point-to-point, in no way indicative of the end-to-end experience of the end-user and their application. Moreover, the SLA goes with the customer following a migration from the legacy circuit(s) to other transport options. In summary, these traditional SLAs are limited and application-unaware.

Figure 1. Traditional SLAs Versus Cisco IOS IP SLAs



IP networks are currently held accountable for carrying all types of applications that require networks and the Internet to provide the appropriate level of service for the appropriate application. These include integrated web, voice, video, and business-critical applications. In order to make real-time network decisions that ensure application Quality of Service (QoS), it is important to measure end-to-end network performance statistics as data traverses the network. This end-to-end measurement is the only way to accurately assess whether the performance statistics are satisfactory enough to support the application(s).

Market Drivers for Enhanced SLAs

Multiple factors drive network convergence and the corresponding need for performance-sensitive networks:

Business-Critical Applications

All customers select which applications are business-critical, in terms of their individual needs. Examples include Enterprise Resource Management (ERP), Customer Relationship Management (CRM), Material Requirements Planning (MRP), portals, and client-server applications. In order to meet business objectives, companies must deliver these applications with a high degree of network performance. This can only be accomplished with a dynamic network that measures, adjusts, warns and assists with problem identification and troubleshooting.

Administrators can use a variety of benchmarks, including delay, packet loss, jitter, packet sequencing and connectivity, to gauge the quality of service received by the end user. An IP infrastructure that supports these metrics ensures a successful network-wide rollout of business-critical applications.

Voice

Cisco customers can leverage converged networks to route some or all voice traffic over data networks; benefits include the efficiency of IP , flexibility, avoiding tolls, increased cellular traffic, and cost savings.

In exchange for these benefits, administrators must ensure that their network QoS meets voice requirements. Most Cisco customers have met this requirement by over-provisioning and deploying excess bandwidth. This strategy can meet short-term goals; however, networks need improved efficiently, utilizing performance-awareness in order to meet customer demands in today’s rapidly changing and competitive global marketplace. Dedicating a single network connection to voice, video, and data traffic reduces network complexity, resulting in measurable cost savings in hardware, software, and management.

Audio/Video Conferencing

As virtual teams, global offices, and telecommuting are become more frequent, there is a corresponding increase in the importance of video and audio services. Examples of emerging applications include:

- Audio and web conferencing tools allow real-time collaboration (ie: Cisco Latitude Communications’ MeetingPlace)
- VoIP Phones in home offices enable telecommuters to traverse the company network
- Seamless interface for scheduling and hosting multimedia conferences
- Unified messaging: integration of voice, email, fax, and scheduling into one interface accessible both via voice and online

All of these value-added applications depend on an IP network that can deliver an appropriate level of network performance.

VPNs

Some of the technologies that have enabled and will continue to fuel the phenomenal expansion of IP VPNs include Generic Routing Encapsulation (GRE), IPsec Multiprotocol Label Switching (MPLS) VPN. VPNs provide the cost effective sharing of infrastructure, while Cisco IOS IP SLAs allows and accelerates the deployment of SLAs across those VPNs.

MPLS VPNs, for example, have gained popularity with customers who are familiar with the security and features of Layer 2 connections (ie: Frame Relay or ATM). MPLS VPNs offer a multitude of features, including:

- Security: restrict access to only member routers of the VPN
- Easily configured shared communities of interest or connectivity between customers
- QoS and differentiated services
- Bandwidth Guarantees

Customers can easily converge network traffic over the MPLS VPN links when the provider can provision the requested bandwidth and QoS with confidence. The increasing frequency of MPLS VPNs with QoS guarantees requires providers to pay closer attention to network performance. Cisco IOS IP SLAs has specific features that are targeted at MPLS VPN, as well as other VPN environments.

Outsourcing

Many enterprises outsource their network and network services from service providers. In the agreement, fees are based upon certain criteria related to network uptime, mean-time-to-repair (MTTR), bandwidth, latency, packet loss, and occasionally jitter. The agreements can also be specific to traffic; for example, SAP (premium), internet (silver) and email (bronze).

The enterprise must track and confirm that the service provider and consultants are meeting the requirements of the agreement. It must deploy technology to track these key network metrics, and then feed that information into an application for report display. These enterprises also need threshold capability, so they can be notified as soon as there is a service level violation.

Service Provider Integration

Global enterprises must support applications that traverse multiple Service Providers. Cisco IOS IP SLAs can provide a standard measurement system to ensure consistent SLA metrics and quality across integrated Service Providers.

Improving SLAs

It is essential to improve upon traditional SLAs in order to effectively support market drivers, such as business-critical applications, voice, audio/video conferencing, and VPNs. Network equipment that can measure and track the performance metrics of a network and subsequently enforce an enhanced SLA is imperative. The attributes of an improved SLA include:

1. **End-to-end coverage:** provides both greater reach and more accurate representation of the end user experience
2. **Sophistication:** statistics (ie: delay, jitter, packet sequence, Layer 3 connectivity, path, and download time) can be broken down to bi-directional and round-trip numbers, which provide a richer vein of data
3. **Accuracy:** applications that are sensitive to slight changes in network performance require precision of measurement far beyond that of ping testing with multi-millisecond granularity
4. **Ease of deployment:** large networks can leverage existing equipment features, thus resulting in immense time and cost savings
5. **Application-aware:** the ability to leverage Layers 3 through 7 simulates the performance statistics for given applications and supports application-aware SLAs
6. **Pervasive:** network equipment supports a spectrum of hardware, from low- to high-end router and switches, which opens deployment possibilities and flexibility

Many customers are currently recognizing the need for more sophisticated SLAs, which can support application delivery over a converged network. Many Service Providers now provide round-trip delay, packet loss, and connectivity as metrics in their SLAs; however, these SLAs still may not maximize accuracy and efficiency.

The problem with these SLAs is that the VPN Service Provider recommends a contractual cushion, in order to avoid SLA penalties and to ensure that it meets the stated network performance goal. Customers are less likely to rely on this weakened SLA and use the service for deploying a performance-sensitive application. They are also hesitant to deploy a VPN solution that might require multiple Service Providers for global reach, as the combined SLAs would suggest application failure. For example, delay SLA target over the WAN is set as 150 milliseconds when 50 milliseconds is required for a customer to deliver a VoIP solution when factoring in delay at both LAN networks.

To ensure application delivery for customers, SLAs need to be tight. An IP SLA is an SLA that is set very precisely and thus provides a service level that is both realistic and high quality. Service Providers that support improved IP SLAs have the opportunity to increase their business and to successfully rollout new applications. In order to tighten network SLAs, Service Providers need technology that support metrics and accuracy within the IP infrastructure.

In order to build an end-to-end network SLAs, customers need to understand performance expectations for platinum, gold, silver, and bronze levels of traffic out to the customer premise equipment handoff point. The predictability and reliability of a corporation's global intranet can enable unprecedented efficiencies and cost savings.

FULFILLING THE NEEDS

Cisco IOS IP SLAs Introduction

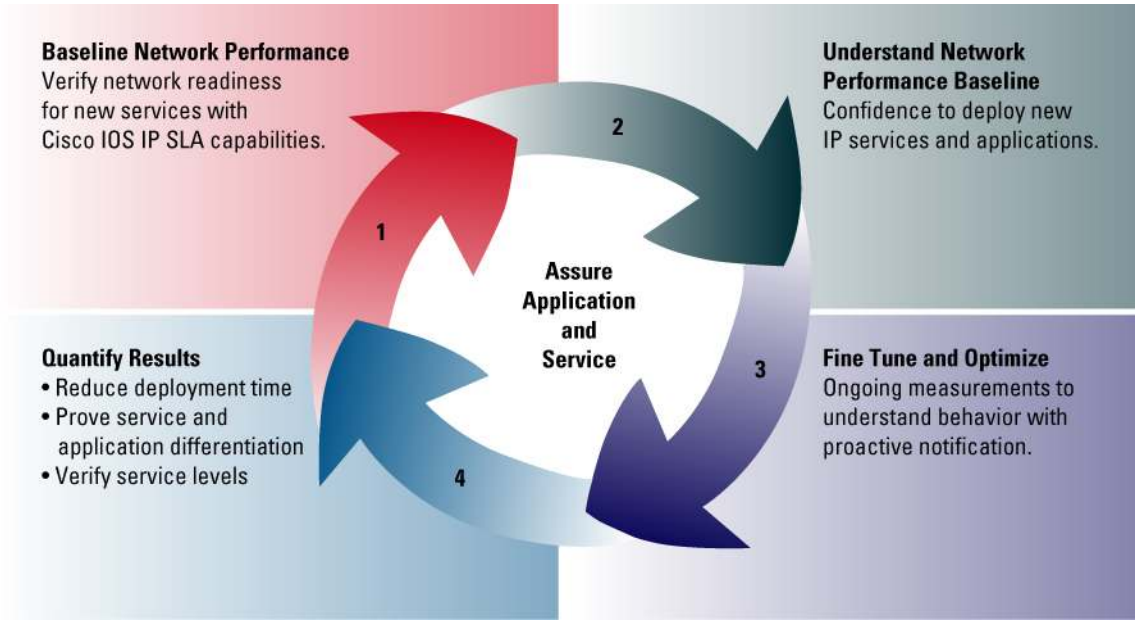
Cisco IOS IP SLAs, a core part of the Cisco IOS Software portfolio, has grown from technology previously known as Cisco IOS Service Assurance Agent (SAA). It performs active monitoring by generating and analyzing traffic to measure performance between Cisco IOS Software devices or to network application servers. Cisco IOS IP SLAs enables functionality beyond the traditional SLAs:

Table 1. Traditional SLAs Versus Cisco IOS IP SLAs

Requirement	Traditional SLAs	Cisco IOS IP SLAs
End to End Monitoring	Limited	Yes
No Hardware Cost	No	Yes
Pervasive	Frame Relay or ATM Only	Yes
Ease of Deployment	Poor	Yes
QOS Support	No	Yes
Latency Measurements	No	Yes
Voice Measurements	No	Yes
IP Application Aware	No	Yes
Layer 2 Support	Frame Relay or ATM Only	Yes

The Cisco IOS IP SLAs deployment cycle reduces the deployment time for new applications. It enables users to understand their deployed IP service network performance, and realize benefits from managing and proving service and application differentiation.

Figure 2. Cisco IOS IP SLAs



Cisco IOS IP SLAs collects statistics regarding delay, packet loss, jitter, packet sequence, connectivity, path, and download time. The packets have configurable IP and application layer options, including source and destination IP address, UDP/TCP port numbers, ToS byte (includes Differentiated Services Code Point (DSCP) and IP Prefix bits), VRF, and URL. As it is 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 has 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

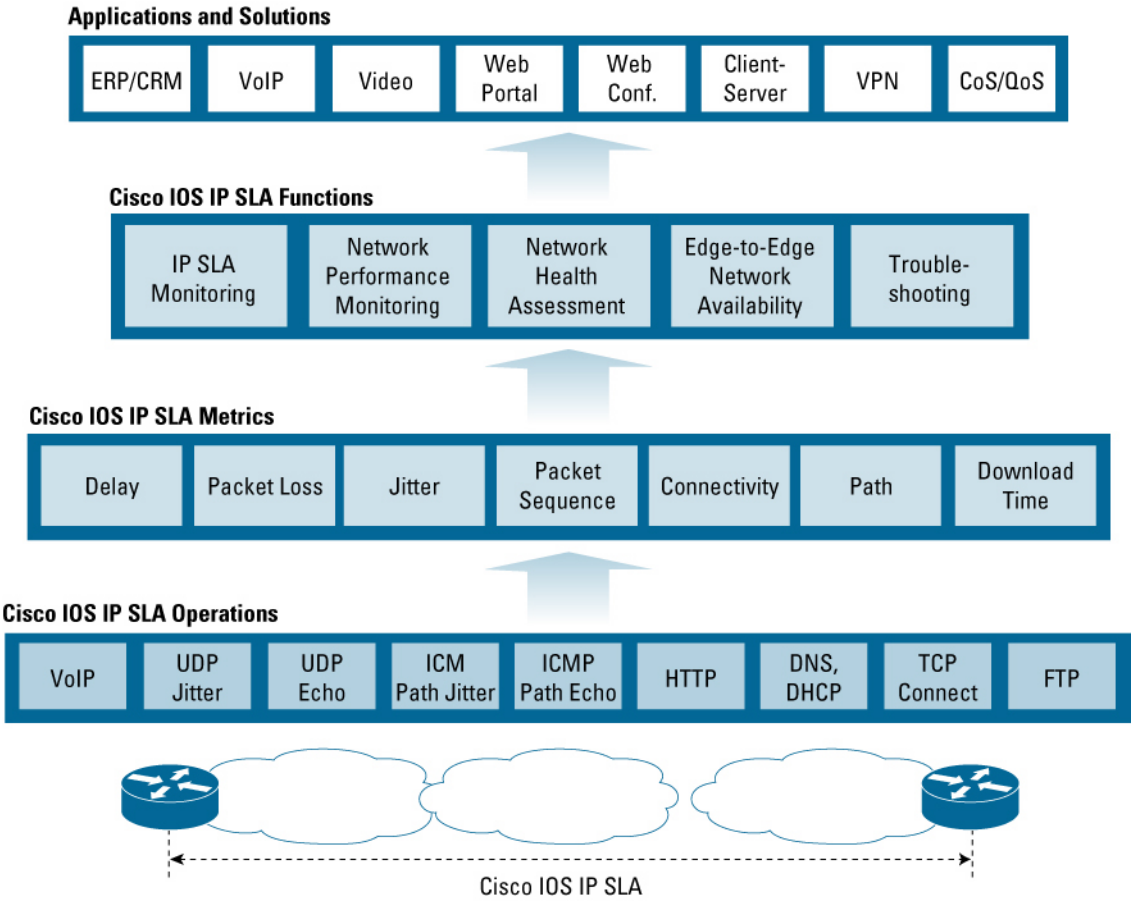
These capabilities enable enforcement of the following network functions:

- Cisco IOS IP SLAs monitoring
  - SLA monitoring, measurement, and verification
- Network performance monitoring
  - Measure jitter, latency, or packet loss in the network

- IP Service network health assessment
  - Verify the network QoS is sufficient for new IP services
  - Continuous, reliable, and predictable measurements after service deployment
- Edge-to-edge network availability monitoring
  - Proactive verification and connectivity testing of network resources (ie: what is the network availability of an NFS server used to store business critical data from a remote site?)
- Troubleshooting of network operation
  - Consistent and reliable measurement immediately locates problems and reduces troubleshooting time

Each of these functional areas provides support for the successful rollout of business-critical applications. Cisco IOS IP SLAs supports these functions via a series of operations. Each operation has certain capabilities, metrics, protocol, and configurable options. The selection of the correct operation depends heavily on the required application and function.

Figure 3. Application Rollout Support from Cisco IOS IP SLAs Technology



There are currently fifteen unique Cisco IOS IP SLAs operations, each of which monitor different metrics, target different services, and possess unique characteristics. The appropriate Cisco IOS IP SLAs operation depends on the required application:

- **Enterprise Resource Planning (ERP) integration software**
  - Primary operation is UDP Jitter (deploy with larger interval setting) for network health monitoring
  - ICMP PathJitter: troubleshooting and UDP Echo to the non-Cisco devices
  - Use TCP Connect for connection times to database servers. Leverage ICMP PathEcho for troubleshooting
  - Examples: SAP, Oracle, JD Edwards
- **Critical database transactions:**
  - Primary operation is TCP Connect
  - Leverage ICMP PathEcho for troubleshooting
  - Examples: Oracle and Access
- **Customer relationship management (CRM) applications**
  - Primary operation is UDP Jitter (deploy with larger interval setting)
  - ICMP PathJitter is for troubleshooting and UDP Echo to the non-Cisco devices
  - Examples: Capital One, Fidelity and Vanguard Group

Voice

  - Voice is a key area of growth for Cisco IOS IP SLAs. With accurate bidirectional delay, bidirectional jitter, and Mean Opinion Score (MOS) voice quality score statistics the administrator can provide a full suite of performance statistics for a voice environment.
  - Primary operations are: UDP Jitter, UDP Echo, and ICMP Path. Jitter operations also address voice. Recently, Cisco has also released its VoIP operation.

- **Material Requirements Planning (MRP) applications**
  - Primary operation is UDP Jitter (deploy with larger interval setting)
  - ICMP PathJitter is for troubleshooting and UDP Echo to the non-Cisco devices
- **Real-time applications**
  - Primary operation is UDP Jitter (deploy with larger interval setting)
  - ICMP PathJitter: troubleshooting and UDP Echo to the non-Cisco devices
- **Video**
  - Integrated video and web conferencing software has begun the drive in this segment
  - The primary operations used in video environments are VoIP, UDP Jitter, ICMP PathJitter, and UDP Echo
  - ICMP PathJitter: troubleshooting and UDP Echo to the non-Cisco devices

- **VPN**
  - MPLS leverage-specific: MPLS VPN aware functionality paired with the appropriate operation. Cisco IOS IP SLAs has specific MPLS VPN aware functionality that pairs with appropriate operations
  - Primary Operations such as VoIP, UDP Jitter, UDP Echo, ICMP PathJitter, and ICMP PathEcho
  - When leveraging Cisco IOS IP SLAs in a Layer 3 MPLS VPN network, there are three deployment scenarios:

  1. For PE to CE -> VRF Aware IP SLAs (in both directions)
  2. For PE to PE -> global routing table
  3. For CE to CE -> Site to Site
     ICMP Echo or UDP Echo can be used for non-Cisco devices

- **QoS**—the Type of Service (ToS) byte can be configured on Cisco IOS IP SLAs operation packets, and it sets the Class of Service desired. For example, the administrator can set the following parameters:
  - Platinum: voice
  - Gold: mission-critical applications (ie: Oracle)
  - Silver: web (HTTP) traffic
  - Bronze: email (SMTP)

Administrators must set the ToS byte for packets that belong to these applications to reflect the Class of Service to which it belongs, so routers and switches to treat it accordingly.

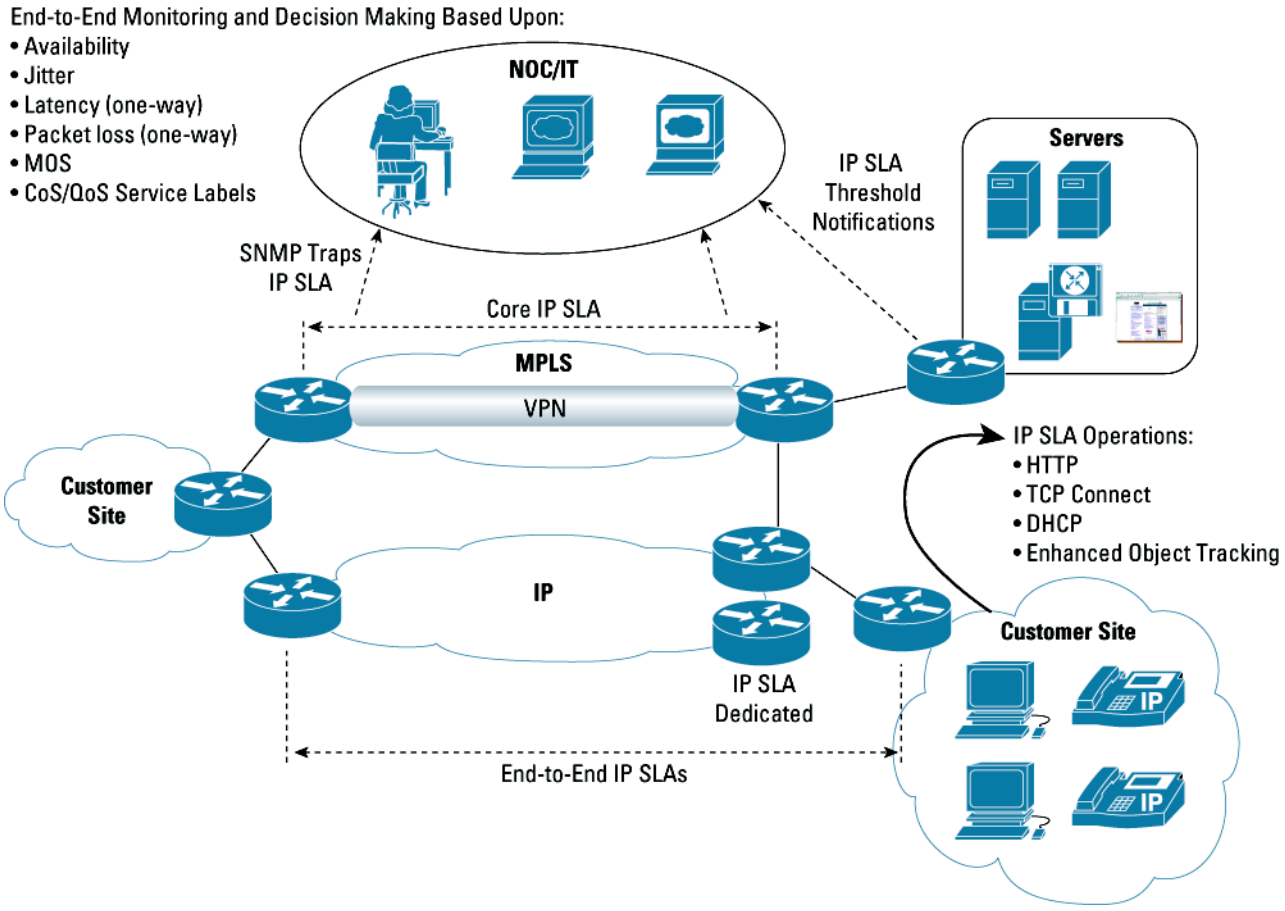
- **Web Portals**
  - Primary operation is HTTP, which includes DNS request response time, TCP connection, time to first byte, and HTTP transaction time
  - DNS and TCP Connect operations can be run separately
  - Example: HTTP web traffic
- **Client-Server traffic**
  - Primary operation is TCP Connect for connection times to servers
  - Leverage ICMP PathEcho for troubleshooting
  - Example: Citrix
- **Web Conferencing**
  - Primary operation is UDP Echo operation: delay and packet loss
  - ICMP PathEcho: troubleshooting
- **E-Commerce**
  - Primary operation is UDP Echo operation: delay and packet loss
  - ICMP PathEcho: troubleshooting
- **Stock transactions**
  - Primary operation is UDP Jitter (deploy with larger interval setting)
  - ICMP PathJitter: troubleshooting and UDP Echo to the non-Cisco devices

- **Internet Messaging (IM)**
  - Primary operation is UDP Echo operation for delay and packet loss
  - Leverage ICMP PathEcho for troubleshooting

Selecting and deploying the correct operation is critical to designing an IP infrastructure that successfully supports an application rollout.

Leveraging Cisco IOS IP SLAs with the aforementioned technologies and features yields a sensitive network that is entirely responsive to critical metrics. Figure 4 illustrates how Cisco IOS IP SLAs operations are used for server monitoring, as well as Cisco IOS IP SLAs concepts such as a dedicated (shadow) SLA router and SNMP traps for threshold notifications.

Figure 4. IP SLA Architecture Overview



Measurement Accuracy Leveraging Cisco IOS IP SLAs Responder

A primary benefit of Cisco IOS IP SLAs is accuracy, embedded flexibility, and cost-saving, a key component of which is the Cisco IOS IP SLAs responder enabled on the target device. When the responder is enabled, it allows the target device to take two timestamps: when the packet arrives on the interface at interrupt level and again just as it leaves. This eliminates processing time. This timestamping is made with a granularity of sub-millisecond (ms). The responder timestamping is very important because all routers and switches in the industry will prioritize switching traffic destined for other locations over packets destined for its local IP address (this includes Cisco IOS IP SLAs and ping test packets). Therefore, at

times of high network activity, ping tests can reveal an inaccurately large response time; conversely, timestamping on the responder allows a Cisco IOS IP SLAs test to accurately represent the response time due. Figure 5 demonstrates how responder works.

Figure 5. Cisco IOS IP SLAs Responder

Four timestamps are taken to make the calculation for round-trip time. At the target router, with the responder functionality enabled, Timestamp 2 is subtracted from Timestamp 3 to produce the time spent processing the test packet. This is represented by delta (Δ). This delta value is then subtracted from the overall round-trip time. Notice that also the same principle is applied by Cisco IOS IP SLAs on the Source Router where the incoming Timestamp 4 is also taken at the interrupt level to allow for greater accuracy.

For information about the superior timestamping and accuracy of Cisco IOS IP SLAs, review *Accurate Network Performance Monitoring Using Cisco IOS IP SLAs*:

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

An additional benefit of two timestamps at the Target Router is the ability to track one-way delay, jitter, and directional packet loss. These statistics are critical because a great deal of network behavior is asynchronous. However, to capture one-way delay measurements, the configuration of both 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.

In summary, the Cisco IOS IP SLAs responder provides enhanced accuracy for measurements, without the need for dedicated third-party external probe devices. It also provides additional statistics, which are not otherwise available via standard ICMP based measurements.

Cisco IOS IP SLAs Thresholds

Troubleshooting and enforcement threshold functionality are critical aspects for supporting successful SLA monitoring. Consistent and reliable measurement immediately identifies problems and reduces troubleshooting time. To confidently deploy an SLA, mechanisms must immediately notify administrators of any possible violations. Cisco IOS IP SLAs can send SNMP traps for certain “triggering” events:

- Connection loss
- Timeout
- Round trip time threshold
- Average jitter threshold
- One-way packet loss, jitter, MOS, and latency (available in Release 12.3(7)T)

Alternatively, Cisco IOS IP SLAs can trigger another Cisco IOS IP SLAs operation for further analysis. For example, the frequency can be increased, or an ICMP PathEcho or ICMP PathJitter operation can be initiated for troubleshooting.

MANAGING CISCO IOS IP SLAS

SNMP

Cisco IOS IP SLAs has a MIB called RTTMON-MIB. Each network performance statistical category spawns IP SLAs MIB variables and corresponding Object Identifiers (OIDs). Using these variables and OIDs, customers can build custom equations to monitor the specific statistic(s) in which they are interested. The most frequently requested calculations include:

- Jitter
- Packet Loss Ratio

RTTMON-MIB: http://www.cisco.com/pcgi-bin/Support/Mibbrowser/mibinfo.pl?mn=CISCO-RTTMON-MIB

Cisco IOS IP SLAs Hardware Support

- Linksys (IP SLAs Responder only)
- Cisco 800, 1700,1800, 2600,2800, 3500, 3750, 3600,3700, 3800, 6500, 7200, 7500, 7600, 10000, and 12000 Series Routers. Future support includes CRS-1, ONS ML Card, and Cisco 7970 IP phones in 2005.

Cisco IOS IP SLAs Dedicated or SLA Router

Routers that either source or respond to Cisco IOS IP SLAs test packets do so while performing all the primary routing and switching features that are configured on that particular hardware. Much like keepalives, these test packets have a negligible performance impact on the router. However, when there is a larger number of Cisco IOS IP SLAs operations, then the CPU and memory impact needs to be calculated.

For additional information about performance statistics, please review *Cisco IOS IP SLAs User Guide*: http://www.cisco.com/go/ipsla

If there are thousands of test destinations being sourced from the router, then a “dedicated router” or “shadow router” maybe the best choice for deployment. A dedicated router is simply a low-end router dedicated to sourcing Cisco IOS IP SLAs operations. The advantages of deploying a dedicated router include:

- Easy upgrade of Cisco IOS Software release on the dedicated router
- Separate memory and CPU requirements from hardware in switching path
- Management and deployment flexibility

Dedicated routers are most appropriate when the deployment plan calls for the operations to be sourced from the edge of the core network (ie: Provider Edge [PE]) location in a Service Provider network. The Cisco 1700, 1800, 2600, 2800, 3600, 3700, 3800 and 7200 Series Routers are frequently used as dedicated routers.

Partners

Cisco IOS IP SLAs is supported by a wide range Cisco applications and a wide range of in-house partners. The list of partners and details is available: http://www.cisco.com/go/ipsla

Cisco Applications:

- Cisco IP Solution Center (ISC)
- Cisco Works Internetworking Performance Monitor
- CiscoWorks IP Telephony Environment Monitor

Third Party Partners:

- Agilent
- Concord Communications
- Crannog Software
- InfoVista
- HP
- Micromuse
- Wired City

The following is an overview of how one of the Cisco partners takes advantage of Cisco IOS IP SLAs.

Concord Communications—eHealth Suite®

Cisco has partnered with Concord Communications to deliver a scalable, highly integrated solution for maximizing the metrics provided by Cisco IOS IP SLAs. Concord's eHealth Suite offers an ideal bridge for understanding the end user experience in context with the network data, allowing true verification of SLAs to the business. This leverages a combination of the key metrics offered by Cisco IOS IP SLAs with network data and precise, tangible end user data.

Finally, IT can validate and proactively improve the end user experiences while providing seamless service. Concord's eHealth Suite allows network administrators to meet these challenges with its approach to Business Service Management. Building on a solid foundation in network and application performance management, Concord leverages its strengths to measure the end user experience. The end user is concerned with the performance of their IT Infrastructure relative to the application service delivery that they require to drive their business. Concord maps devices and applications, measures application performance end to-end, and manages to the class of service required.

Concord Communications delivers a software product suite that is used by over 3,500 customers globally. Concord's eHealth suite provides support for Cisco IOS IP SLAs, NBAR, QoS, NetFlow and all other Cisco devices and technologies.

Cegetel

Cegetel was established in 1998 and now serves more than 3.2 million subscriber lines and 16,000 Enterprises.

Their managed service offering, Fedelan, offers three classes of service—standard, critical, and real-time—across service packages ranging from entry-level to customized, to a growing customer base.

Customers view the same real-time performance data as the Cegetel operations staff through a web portal, increasing the popularity of Cegetel's offering.

"As we continued to expand our IP VPN offerings, we required a performance management solution that would meet today's business challenges while strategically growing with Cegetel into the future."
–Marc Noblet, Network Vice President, Cegetel.

Can the Application run?

The eHealth Suite builds on the fundamental network management to layer on application response for IP Networks. Actively tracking response time across the network, whether measured between provider edge routers or between customer edge routers. Active testing is done using Cisco IOS IP SLA. Metrics such as availability, response time, latency, packet loss, echo, and jitter can be actively measured for each CoS being delivered and stored in the eHealth database for reporting and analysis. Alongside application specific tests like Mean Opinion Scores (MOS) for VoIP network monitoring.

SLA compliance and capacity requirements are managed with a combination of reports. Reports of Service Availability, Trends, and per-CoS reports on traffic in/out, discards, delay and bandwidth usage give an accurate picture of performance against the SLA. Specific Service Level reports can be presented in several formats and levels of detail, geared to different audiences. Powerful combinations of data presentation can be placed into a executive and business service portals for real time non IT viewing of application, system and network data.

SUMMARY

As the single converged network carrying business critical applications, voice, video and data traffic is increasing in popularity and feasibility, the needs for network equipment that is performance aware becomes greater. Cisco IOS IP SLAs provides exactly the statistics that can serve as a building block towards rolling out SLAs that support business critical applications.

For additional information about Cisco IOS IP SLAs, please visit: http://www.cisco.com/go/ipsla

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: 31 0 20 357 1000
Fax: 31 0 20 357 1100

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on **the Cisco Website at www.cisco.com/go/offices.**

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia • Cyprus Czech Republic • Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland • Israel Italy • Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland • Portugal Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden • Switzerland • Taiwan Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

204171.g_ETMG_AE_2.05

Printed in the USA