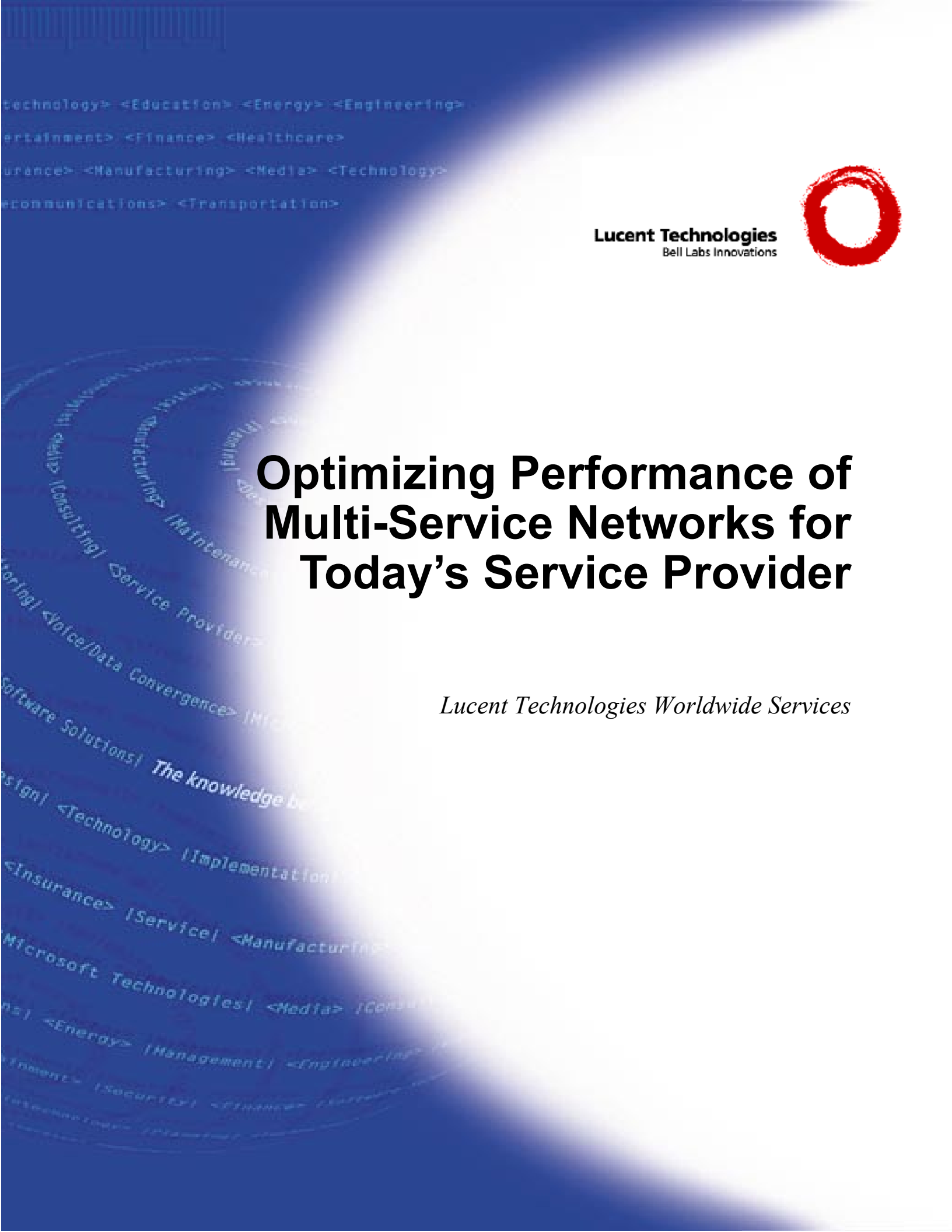

Optimizing Performance of Multi-Service Networks for Today's Service Provider

Lucent Technologies Worldwide Services

Lucent Technologies
Bell Labs Innovations

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Introduction

Recently the number of Service Providers has skyrocketed. Because of this increase in number, each provider is aggressively seeking a niche somewhere in the global network infrastructure to offer their services to a public eager to outsource IT activities. Although outsourcing is certainly not new, the complexity and scale of services is changing dramatically.

Driven primarily by enormous growth in eBusiness, managed services now include not only voice and wide area network (WAN) data services but also includes digital subscriber line (xDSL) and asynchronous transfer mode (ATM) transport services, virtual private network (VPN) and dynamic host configuration protocol Internet protocol (DHCP IP) services, co-location support, wireless services, and outsourced services such as web hosting, B2B, B2C, messaging, and hosted applications. Differentiated levels of service are a key feature that will enable emerging Service Providers the ability to distinguish themselves from the rest, in this highly competitive market.

The ability to deliver end-to-end Quality of Service (QoS), including latency and bandwidth availability guarantees, enables a Service Provider to provide preferential treatment to specific types of traffic on the network. In order to achieve ultra-high levels of QoS, performance of both the core and the edge of the network must be guaranteed by the establishment of Service Level Agreements (SLAs). An SLA is a Service Provider's pledge to deliver an agreed upon level of network and/or application-level performance.

Delineation of gold, silver, and bronze quality service levels will create new revenue streams for Service Providers capable of delivering on their performance promises. If you can offer higher quality services—and prove that you've done it—you'll be able to demand higher revenue from customers willing to pay for better service.

However, before anyone will buy preferential quality services, you must prove you can deliver on your SLAs. In order to accomplish that, you must have tools and services that enable you to measure both network infrastructure metrics and end-to-end application performance to control the quality of service delivered to End Users. Moreover, when service quality degrades, you need tools to help you find the problem, diagnose it, and fix it quickly to ensure that you remain within the bounds of your SLAs.

To be successful, every Service Provider must pay careful attention to monitoring the quality of the services they provide in order to ensure immediate and ongoing customer satisfaction. The dynamic IT market we enjoy today is very volatile, and customer loyalty can fall by the wayside quickly if Service Level Agreements are breached. The winners will be those Service Providers who seize the opportunity to forge ahead with quality services that can command a premium price for delivering successful business solutions.

In this paper we will examine the issues faced when managing the performance of multi-service networks. We will explore some of the problems involved with measuring and reporting on service quality and discuss some of the ways to approach finding a resolution. In this discussion, insight will be gained into the major performance management challenges faced in today's rapidly evolving market for managed services.

Performance Management Challenges for Service Providers

IT applications that support major business-critical activities such as ERP, supply chain management, human resources (HR), manufacturing and logistic systems, require large amounts of bandwidth and are often very sensitive to network delays. In this environment, measurement and management of end-to-end performance is absolutely essential because many of these applications directly affect the operation and success of the entire business.

This performance management challenge presents Service Providers with a great opportunity. By providing precise, thorough performance management for the multi-service infrastructure, Service Providers can increase profitability with value-added services as well as enhance customer loyalty by providing customer-oriented SLA reporting. Moreover, with the right tools and procedures for performance management, Service Providers can more efficiently utilize the network infrastructure through accurate capacity planning.

Holistic Nature of Performance Measurement

Service Providers who want to achieve successful performance management are faced with numerous elements such as; network infrastructure, computer systems, databases, application programs and end user needs. These elements collectively make the task enormously complex. The holistic nature of performance management presents a fundamental problem: if application X is responding slowly, how do you determine exactly what the root cause is?

Yesterday, adding bandwidth could often solve a performance problem but not today. Today, network elements are more complex, their potential problems are subtler and interconnections with other Service Providers have a significant effect on performance. For many reasons, it is not cost effective to simply lay down fatter pipes.

Often, throwing capacity at a QoS problem won't even address the real source of the problem causing a performance slowdown. So one would say, "why not let the other guy try to solve problems that way". Savvy Service Providers will dig deeper for a solution, recognizing that the right approach to performance measurement can enable them to deliver differentiated services that produce satisfied customers.

Managing a Complex Environment

Unlike an enterprise organization that has end-to-end control over most of the IT network affecting their activities, a typical Service Provider faces a much more difficult network environment with many different elements and relationships that are simply not under the control of a single organization. In this more horizontal environment, it's critical to monitor network performance closely.

There can be many different Service Providers in the value chain providing network-hosted applications to an end user. For example, a CyberCarrier (a Service Provider that has overall responsibility for both the transport and the data center) hosts an application service provider (ASP), which in turn hosts applications for end user customers. In another case, a Service Provider may be buying backbone capacity from, say, MCI, a Data Center from another provider, and other services from yet another direction. Carriers must all monitor each other because end-to-end service delivery to the customer goes through numerous places over which the carrier, in many cases, has no control.

Worse yet, because more parties are involved in delivering the services, there are now more places in the value chain that can go awry, and more opportunities for mismatched configurations. This makes accurate measurement and management of the network infrastructure and applications all the more critical.

Moreover, what's really important for end users is response time of the application. Although it's loosely connected to network performance, application response is a key measurement of user satisfaction. However, as services become more complex, it is harder to measure the end user performance and satisfaction. It becomes increasingly difficult to measure any part of the network and determine if the customer is getting the service they need and expect. Never mind round-trip delays, application response times, transmission control protocol/Internet protocol (TCP/IP) or detailed measurements, all they want to know is when I attempt to log into an application, do I get in quickly? You really need to measure *both* the network and the end user experience.

Unique Challenges for Each Service Provider

Each type of Service Provider must face myriad challenges that are unique to the kind of service offered:

- Backbone service providers must efficiently allocate enormous capital expenditures and keep track of numerous complexities brought about by rapid technology change. In addition, they must be able to forecast capacity needs well in advance of service degradation. Merely having fault information provides an incomplete picture.

- Managed service providers, faced with commoditization of services, need to differentiate their services by establishing and measuring customer-oriented SLAs. Competitive pressures for performance and bandwidth mandate that these firms are able to accurately assess bandwidth requirements to maintain satisfactory service levels for their clients.

- Service Providers who manage a network operations center (NOC) are confronted with diverse customer networks that create a huge multi-vendor challenge, coupled with the daunting high cost of customer care. In this environment there is enormous competitive pressure for extensive performance reporting, and each customer demands complete visibility into their part of the network services and into their applications.

- Service Providers delivering web hosting or applications, or providing co-location equipment and services know that customer satisfaction is measured by the end user experience. In particular, ASPs are definitely in the hot seat because they handle business applications that impact day-to-day business activities of their clients. Customer's demand business-oriented SLAs that delineate response times and availability for business transactions. It's an enormous challenge because the end-to-end path crosses many providers, even national borders, with myriad administration details.

- Competitive local exchange carriers (CLECs), Data local exchange carriers (DLECs), and others providing last mile services must incorporate emerging technologies that may lack adequate management capabilities. Outsourced capacity is difficult to manage, and end users are expensive to support. In this arena, increased competition means new Service Providers must create differentiated service offerings, putting greater emphasis on the need to deliver superior network performance management.

- CyberCarriers moving into the network hosting space have control over both the network and the data center used to deliver applications to end users, and must assume responsibility for an enormous variety of complicated, interrelated issues. A superior infrastructure which consists ofintegrated hardware, software, network equipment and support services must be in place to meet stringent ASP requirements

for QoS, security and reliability delivered to end users. Edge-to-edge solutions across multiple network elements must be supported by network performance management systems that can verify delivery of contracted services.

The Value of Performance Engineering

Today we see rapid changes in the IT infrastructure as enterprises look to service providers for solutions too increasingly complex business needs. Enterprise customers are no longer interested simply in the provisioning of bandwidth and transport services. These customers want full service solutions supported by verifiable, meaningful SLAs.

In this new environment, IT organizations often expect more from their Service Providers than they do from their own internal support groups. If you're providing hosted applications from a Data Center, the performance of every network element that enables delivery of your services directly impacts the success of your business.

Your ability to differentiate and validate high quality service offerings that is better than your competitors can determine your success. Providing timely, accurate SLA verification data is critical to differentiate your services and maintain a satisfactory relationship with a base of contented customers.

A key element in the equation is user perception. From the view of a user's desktop running a business application, the key indicators of satisfaction are transaction response time and application availability. In a traditional network management environment, good performances dealt with whether the network was up or down. Here you are obliged to focus on a more gray area of application performance from an end user perspective. If you provide application services, your success depends on how well your customers perceive that you have met your service level objectives defined in your SLAs.

The View from Two Sides

Performance management methods should align IT performance with business metrics by translating IT service elements into business terms meaningful to end-users. As shown in the table, two distinct viewpoints of network performance illustrate the gulf that must be bridged by Service Providers to raise customer satisfaction with their services.

Service Providers Typically Monitor	*What Customers Care About*
• Packets per second • Packet loss • Roundtrip time • Response time • CPU utilization	• How long to submit an order • Time for credit approval • Availability of P.O. system • Timely inventory updates • Accurate billing

For most users of IT services, they don't particularly care much about the platforms, protocols, and transports. However, what they do care about is, 'when I log onto email, will I get my email?' End users are interested in the ability of an application to perform a business process quickly and efficiently with minimal hassle. Usually they don't care what happens behind the scenes.

But you, as the service provider, care as well. You care because you're providing the services, and you're locked into a SLA that puts hard numbers on the availability and performance of the business application. So

you want to be sure to understand as much as possible about what is happening at any instant across the entire end-to-end user experience, including the network, the application and the business process.

New Performance Metrics—Measuring Business Processes

Not so very long ago it was considered sufficient to use technology-centric performance metrics such as round trip time, packet loss, and network device to describe the ability of the network infrastructure to meet SLAs. Today, however, with technology so intertwined with business processes, business executives are demanding information that tells them how well the network is actually supporting their businesses. Performance measurements down to the transaction level are needed to provide the information that enables managers to assess how well their IT infrastructure is helping them achieve their business goals.

Performance management systems available today allow IT professionals the ability to identify, capture and define the performance of specific application business transactions as experienced by the everyday users of those applications. Measurement of business processes as they move from the user's desktop through the network to the destination application server and back provide an understanding of where problems lie and how to fix them.

Because eCommerce business applications are so complex and varied, Service Providers must have visibility into all types of networked applications, including custom applications packaged applications, and browser-based applications. With tools now available, IT professionals can define and capture business transactions for virtually any TCP/IP-based application.

TCP/IP packet analysis can also show how much time was spent on the client, the network, or the server to provide further insight into overall business application performance. The ability to link sophisticated flow analysis technology with meaningful business functions delivers a detailed understanding of eCommerce transaction performance that can help improve service quality, leading to greater customer satisfaction.

Vigilance Helps Maintain SLAs

Performance management must be an ongoing continual effort, entailing constant monitoring of key network and application performance indicators to maintain agreed upon service levels. Precise, appropriate performance monitoring can give business managers insight into their business operations and enable them to optimize resources, both today and in the future.

Yesterday. Monitoring and recording historical performance data establishes where you've been and allows you to analyze trends and understand how usage has changed over time. Has usage of this transport, application or service increased or decreased? Has overall performance improved or degraded? Access to historical data helps answer these questions and enables proactive management of services.

Today. Real-time performance information helps identify and repair any element that is out of line. For example, latency and response time data can reveal potential bottlenecks that could prevent the system from operating at optimal performance. The ability to report alarms and faults in a real-time, help-desk environment can greatly facilitate rapid troubleshooting. Armed with this information, you can take necessary steps to ensure compliance with SLAs and proactively involve your customers to ensure their satisfaction and loyalty.

Tomorrow. If your network performance management system tells you where you've been and where you are now, you can do the predictive analysis to meet future challenges. Moreover, you can be proactive in planning future changes by taking action before your networks and applications degrade to the point where violations of SLAs become imminent.

The objective of performance management is to help you understand, from both the network infrastructure and application services perspectives, what has transpired historically, what is happening now, and what you might expect when going forward. Visibility into the performance of all relevant elements of the service equation can offer the possibility to optimize resources regardless of how fast the infrastructure and user needs are changing.

Performance Management: What Do Service Providers Need?

Scalable Foundation

Scalability is surely one of the most pressing issues for Service Providers looking for performance management solutions. The enormous size and growth of some of today's Service Providers and the global distribution of the network infrastructure and services point clearly to the need for highly scalable performance management systems. Service Providers must be prepared to manage and monitor resources for applications that support millions of users whose businesses depend on the reliability of their network resources.

An effective performance management solution must be capable of monitoring end-to-end performance for a multitude of users, all of whom have different service level needs and expectations on network performance. Moreover, the solution must be robust enough to perform quietly in the background, with a minimum of impact on the infrastructure itself.

To meet diverse customer needs, an ideal solution would collect network performance information locally, aggregate the data regionally, and report the information wherever needed worldwide. Design architecture based on the Web would seem to offer the best approach, thus utilizing the power of the Web to achieve the desired scalability.

High Integrity Solution

Ultra-high availability and reliability of a performance verification system is absolutely essential in this highly competitive market. End user customers will be satisfied only with instant, on-demand verification of the reliability, availability, and quality of their services. Downtime in the performance monitoring system that results in an inability to verify SLAs is a recipe for trouble. Knowledgeable Service Providers will insist on a distributed system to achieve fault resilience, allowing data monitoring to continue unabated even if a single server fails.

Flexible, Open Architecture for Data Gathering

In the rapidly evolving Service Provider market the ability to stay current is critical, in so much as being first with new services is essential. As new technologies emerge that provide faster speeds, greater reliability and capacity, you want to quickly incorporate new equipment and services as well as be able to support new applications as soon as they become available.

An open and extensible performance management system enables you to integrate emerging technologies and rapidly begin managing and monitoring their performance to provide added value to your customer base by delivering quality of service data. For example, some systems provide templates that allow users to "teach" the system to recognize new applications or new network equipment without requiring new functionality from the management system vendor.

Open APIs

A well designed performance management system will also include Application Program Interfaces (APIs) that allow you to link the information you gather about network performance to your policy management, billing and provisioning systems. By responding to customers immediately with issues and questions, you'll differentiate your services and gain a competitive edge. Open APIs also help you respond immediately to new product availability. This can be accomplished because you can shorten the normal development cycle by easily programming the performance management tools yourself without having to wait for contract services.

An open system built on industry standards serves to protect you from the unnecessary expense and complexity of proprietary systems. If the foundation of your performance management solution is standards-based, it also facilitates ease of use, shortening the learning curve for your users and providing easier product integration.

Integration with existing network support tools is also vitally important. In a large-scale network environment, new performance management tools should be complementary to current fault management consoles, configuration management tools, inventory systems, and other utilities.

Accurate Performance Measurement

The infrastructure and services delivered by Service Providers comprises a complex mix of network devices, protocols, transports, servers, applications, and end users. Any Service Provider may deploy, support and manage one or more of a comprehensive set of capabilities that includes DSL, ATM, Frame Relay, IP, and wireless services. Services may involve hosted applications, voice over IP (VoIP) , VPN, B2B, B2C, Web hosting, remote access and many others.

To deliver a high level of quality to your customer base, your performance management solution must gather data from multiple points across the network infrastructure and supporting services from many different perspectives. It should be capable of monitoring a wide range of equipment and services from multiple vendors, and visibility must go well beyond just the network devices. Performance management must include the entire end-to-end solution, including applications and business transactions.

Depending on the level of services you offer, your liability may range anywhere from the Internet backbone all the way to the users' desktops. This means that in addition to providing end-to-end visibility, you must be able to distinguish what components of the customer experience are impacted by variations in service levels. If you own only a piece of the entire process, how can you clearly draw a line of demarcation between your piece, and that of the other Service Providers? To identify the limits of your responsibility, every point of demarcation must be clearly identified, measured, and reported by the management systems you utilize.

Where differentiated levels of service are involved, meeting customer expectations is a critical part of the challenge. If you can comprehensively measure and report on the end-user experience from one end of the network to the other including the server, the network devices, the application, and business processes, you avoid a lot of finger pointing. You stand tall in the eyes of your customer when you can clearly define and measure the success of your part of the network performance equation.

Individualized Information Delivery

Customer satisfaction does not come easily in this business. So far, managed services have not generally received high marks, presenting a great opportunity for Service Providers who can take services to the next level. By offering truly differentiated levels of service, you can enjoy the higher margins and profits those services promise to deliver.

How might this be done? By being proactive in providing each customer with documented visibility into the performance of their portion of subscribed services to show that you are meeting the established SLAs. However, due to the complex nature of today's global network infrastructure, along with an extremely broad mixture of vendor equipment, applications, and service offerings from numerous Service Providers, makes this a challenging task.

If you can deliver precise, easily understood SLA information to your customers, you'll be in a class practically by yourself. You can inform customers of potential problems before they occur, allowing for a proactive resolution. Moreover, informed performance measurements can even facilitate customers' requesting additional services and bandwidth because they have visibility into their activity history, current performance and projected future needs.

Partitioned Views of Performance Data

Because each of your customers has unique needs and perspectives, they must be able to monitor their own performance metrics as a way of maintaining accountability for SLAs. The performance management solution you utilize for yourself and your customer base should enable you to partition and view individual customer data, allowing you to provide independent "silo" views of performance and service levels to each customer.

Each customer must be able to view or generate performance reports on demand solely for their own private resources. If Coke and Pepsi share the same network, they each want to see their own private information, but assure competitors cannot.

Bullet-Proof Security

Security and performance are major challenges that Service Providers must conquer to be successful. People will not outsource applications if they don't feel confident they will get at least the same level of performance and security they enjoy in-house. Obviously, all those private silo views of network information must be done in a highly secure manner through password control and other appropriate security methods.

For security purposes everything within the enterprise ordinarily occurs behind a firewall. However, a Service Provider must get through the firewall to allow a client company to see what's going on in the network, which raises security concerns. Tools that properly address this requirement must leverage web technologies to ferret out the information needed while maintaining security and validity of customers' private, business-critical information.

Performance Reporting the Way You Want It

In order to take full advantage of the performance management data collected, many stakeholders (in both your organization and your customers') must have access to specific performance data that addresses their particular needs. Everyone wants a different twist on the information, therefore each stakeholder should be able to obtain up-to-date summaries of network and application performance on-demand, and also be able to drill down to provide further necessary details.

Key Stakeholders in Network Performance Management

- **Business Executives**. Both your own executives and your customers' executives want to see high level summaries of overall network and application performance data to understand the impact of the networks on business operations.
- **Capacity Planners**. To enable both corporate network planners and your own capacity planners the ability to project future usage patterns, allocate costs, and provision resources, they'll need access to historical performance data describing how the network and applications have performed in the past.

- **Service Level Managers**. Your ability to meet and even exceed your end-to-end SLAs is essential to differentiate your company from your competitors. Detailed, in-depth performance reports across the entire end-to-end user experience are necessary to distinguish your service offering. Both your service level managers and your customers' service level management groups must be attuned to the nuances of application and network infrastructure performance to ensure satisfactory end user experience with their business processes.
- **Network Engineers**. In order to tackle the demanding task of maintaining your customers' applications and equipment at peak performance levels, network engineers want detailed performance data for all network devices. Your performance management solution should enable them to rapidly scan through thousands of managed resources and quickly drill down to find the details they need.
- **Application Managers**. Detailed insight into transaction response times, traffic volumes, and application usage helps application managers ensure optimum availability and performance of key applications.
- **Help Desk Managers.** Visibility into critical applications and services can give managers the necessary historical data to predict peak usage periods, anticipate potential problems, and allocate resources appropriately.

Simplified Performance Management Process

An acceptable performance management solution must be highly flexible in order to allow data partitioning for each client, adapt to a wide variety of user service profiles, and support a multiplicity of different SLAs. However, while offering powerful capabilities for managing the network and applications, an SP-class performance management solution must also be easy to administer in order to achieve desired profitability goals.

Administering a large performance management system can be a complex process, and anything that streamlines the process is welcome. A viable solution should offer a simple, intuitive user interface to minimize the learning curve, as well as be easy to install and use.

Moreover, your performance management solution should assure smooth system expansion, allowing it to grow easily from a small initial deployment through to a large-scale deployment. For example, when a new server is added, it should be relatively simple to migrate some of the data to the new server.

If the performance management solution must be customized and configured for the unique needs of each customer, it multiplies the effort with multiple administration points, multiple simple network management protocol (SNMP) polling to the same network elements, and multiple endpoint destinations to gather the same performance information. However, if the performance management solution is standards based and robust enough to allow configuring a distinct set of policies and profiles for each individual client from a single system, your administration task is greatly simplified.

Tangible Business Benefits

By providing insight into the operational efficiency of networks and applications, a superior performance management solution should help reduce overall deployment, maintenance, and operations expenditures. It should also aid in capacity planning and performance analysis to achieve efficient infrastructure utilization.

Furthermore, your performance management solution should provide business-centric views of network performance, to give your customers' managers insight into the strategic applications that run their business.

Performance management for the multi-service infrastructure forms the basis for value-added services that lead to profitability. Moreover, a good performance management solution should deliver customer-oriented SLA reports that help produce customer loyalty.

Summary

We have discussed the importance of measuring and managing the end-to-end performance of multi-service networks to support business-critical activities of end users of network hosted services. However, the holistic nature of performance management, with its many different Service Providers in the value chain and numerous potential problem areas in the network, makes the task extremely difficult.

VitalSuite, a software solution from the Lucent Technologies VitalSoft division, uses a variety of techniques to monitor, measure and manage network and application performance of multi-service IP infrastructures. VitalSuite automatically aggregates performance information to provide on-demand, web-based infrastructure performance and SLA validation data.

To meet Service Provider needs, a performance management solution must be highly reliable, scalable, to meet virtually unlimited growth, and support integration with multi-vendor systems. VitalSuite's distributed, carrier-grade architecture supports infrastructure monitoring and reporting for millions of transport resources and end-user desktops, and is designed with open interfaces for linking with other systems—including billing and provisioning.

Regardless of what happens in the underlying network, end users are most interested in response time and reliability of applications. VitalSuite provides tremendous insight into how network and applications support important business processes by offering views of the transport infrastructure, the services and the applications supported. Providing support for historical, real-time and future performance reporting, VitalSuite enables Service Providers to understand completely the quality of the customer experience.

In order to deliver truly differentiated service quality levels, Service Providers must be able to give each customer documented visibility into the performance of their part of the services. VitalSuite's customer-oriented reporting utilities enable Service Providers to the ability to provide constituents with secure, personalized, controlled access to objective proof of compliance with SLAs. Data-partitioning and security features allow for establishing unique policies and SLAs for mutually exclusive groups such as customers, business units or locations.

VitalSuite Value to Service Providers

- Establish measurable SLAs
- Differentiate service offerings and improved margins
- Reduce time-to-market for new services
- Increase customer satisfaction, retention and loyalty
- Optimize investments in infrastructure expansion
- Enable high-margin IP services

About Lucent Technologies Worldwide Services

In addition to offering the VitalSuite solution for network performance monitoring and reporting, Lucent also provides a wide variety of network services to help Service Providers build, operate and manage their networks. Lucent Technologies Worldwide Services, with a team of over 25,000 professionals, is a global provider of network consulting and software solutions for complex networks, services and applications.

Lucent combines the widest range of networking services along with the greatest depth of networking knowledge, including the largest source of IP and circuit-based knowledge in the world. Lucent's services encompass the entire life cycle, planning, design, implementation, operation, and maintenance.

Also, Lucent's engineers are guided by its Network Engagement Methodology (NEM), a process-oriented management approach which developed thousands of network engagements that are proven effective for translating business objectives into successful technical projects. Lucent Technologies Worldwide Services offers the breadth of services needed by Service Providers to integrate complex networks, applications and services in a multi-protocol, multi-vendor environment.