The New Era *of* Network Performance Management

INSIDE:

Today's networks are highly complex, dynamic environments that demand comprehensive performance management. Fortunately, technologies are advancing to simplify management on some levels and address new challenges on others. This e-book explains why management is more important now than ever and how it can help deliver business-critical applications better and faster, and it describes new functionality emerging in this important area. BY JIM METZLER

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Emphasis on apps boosts need for network management

The network is the provider of applications to end users, but as more applications are added, ensuring that they all work well is challenging. This chapter discusses the drivers behind the need for management and the trends contributing to the complexity of today's network and applications environments.

THE FOCUS IN network performance has been shifting from the network to the application. The network management function is in the process of adopting strategies that focus on the quality of experience (QoE) that a user has with the company's key business applications. Effective application delivery depends on the combination of a robust, secure and highly available infrastructure, application acceleration and optimization over the WAN, and application performance solutions that can minimize user problems relative to accessing critical applications.

The sharpened focus on application delivery has been driving the high growth rate of WAN optimization and is ushering in a new era for performance management solutions that transcend traditional link utilization monitoring and capacity planning to provide:

- Real-time or near-real-time insight into how specific applications and user sessions are performing.

- Performance indicator metrics and granular data that can be used to detect and eliminate impending problems.

- Improved diagnostics and remedial workflow patterns to quickly determine the root cause of performance problems that do occur.

This e-book examines the trends behind the changes in working with performance management so that IT leaders can better understand their network and application dynamics and adapt to them. We'll describe a framework for managing application delivery, illustrating the ways that a performance management solution can help in the implementation and management of an application delivery program. We'll also discuss some of the advanced management capabilities that are available. These capabilities enable performance management to enter a new era driven by the need to ensure the application user's QoE in the face of a constantly growing set of impediments to acceptable application performance.

FACTORS DRIVING INCREASED EMPHASIS ON APPLICATION PERFORMANCE

Several factors are driving the evolution of IT environments and forcing IT organizations to dedicate more of their resources to optimizing application reliability and performance. These factors include:

- **Application proliferation**

Enterprise IP networks must accommodate an ever-increasing variety of network services and applications. In addition to the traditional data applications, converged enterprise networks can support a variety of real-time IP communications applications, including voice over IP, video conferencing, telepresence, streaming video, instant messaging and collaborative sessions. Many enterprises consider these real-time services and applications to be as business critical as traditional enterprise applications, such as ERP or CRM.

Each distinct type of business-critical application can have somewhat different requirements in terms of network performance. For enterprise data applications, the QoE metrics are typically availability and response time. The levels of packet loss, latency and jitter heavily influence the QoE of real-time applications. Configuring

A networking professional monitors network and applications performance in the network operations center at the Interop conference in Las Vegas.

QoS functionality for switches and routers and allocating or limiting bandwidth for different application classes are basic requirements for real-time applications. These techniques, while necessary, do not protect an application from QoE shortfalls, however, especially in cases of anomalous network behavior or faults that degrade network performance.

■ Increased business reliance on network applications

Business globalization and employee decentralization, together with the proliferation of business-critical applications, has made the IP network an indispensable component of normal business operations. Any shortfall in network availability or performance can therefore be translated into business costs in terms of lost worker productivity, reduced efficiency of business processes, or lost business opportunities. According to a Yankee Group survey, application performance issues result in an average productivity loss of 14%.

■ New application architectures

New styles of distributed applications based on Web 2.0 technology and service-oriented architectures (SOAs) are having a significant impact on the complexity of managing application performance. With both of these application architectures, different components of the application may be distributed across servers that reside in geographically dispersed data centers. This means that these newer forms of distributed

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applications create additional flows that traverse the enterprise WAN. The additional data flows increase the sources of delay, packet loss and jitter while complicating the performance monitoring process and demanding increased levels of reliability.

■ Resource consolidation/ centralization

Many large enterprises have ongoing programs to consolidate IT resources by centralizing server, application and data resources in a small number of data centers. With centralization, the branch office user accesses enterprise applications over the WAN rather than on a local server. Centralization can result in dramatic reduction of the costs related to server and application deployment, as well as greatly enhancing the enterprise's security posture. However, centralization increases the volume of business-critical traffic that traverses the enterprise WAN and subjects remote end users to the travails of longer response times that result from the WAN's limited bandwidth and higher latency. The impact of higher WAN latency is particularly pronounced in those instances in which a chatty protocol (which can take hundreds of roundtrips to complete a single transaction) traverses the WAN.

In order to mitigate problems such as those that arise from running a chatty protocol over a WAN, IT departments have deployed WAN optimization controllers (WOCs). WOCs use a variety of techniques to reduce bandwidth consumption and offset the effects of high WAN latencies. The combination of the centralization of IT resources and the deployment of WOCs has increased the demand for performance management solutions that can help monitor and manage the acceptable performance of critical applications over the WAN and verify the benefits of WOC deployment.

■ Virtualization

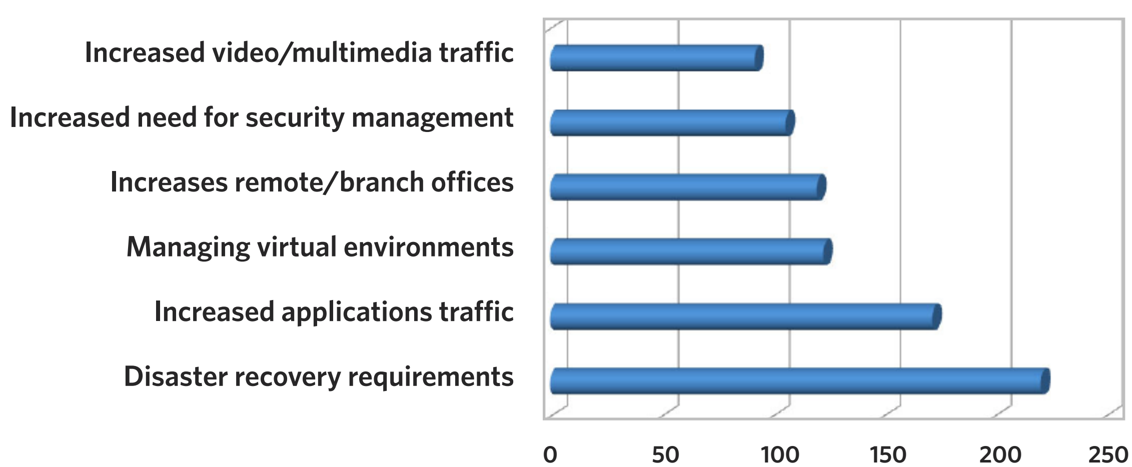
The virtualization of servers and storage is now a well-established aspect of IT programs for consolidation and centralization of resources. In addition, application virtualization and desktop virtualization are two emerging technologies that are particularly effective in simplifying the management of end-user systems because they streamline the IT tasks related to desktop and application support. With application and desktop virtualization, end-user QoE for almost all applications, including personal productivity applications, becomes highly dependent on network performance.

With server virtualization, all the management capabilities employed for physical servers must be extended to cover the virtualized environment as well. For example, management systems that rely on automatic discovery of the network topology must be able to develop an integrated view of the physical and virtual environments. This integrated view of the infrastructure must be able to accommodate the dynamic nature of the virtual environment where virtual machines can be automatically or manually moved from one physical server to another.

Server virtualization presents a number of challenges for performance management. For example, the VMs that reside on a given physical server communicate with each other using a virtual switch function within the server's hypervisor software. Unfortunately, unlike the typical physical switch, a vSwitch typically provides limited traffic visibility for the traffic that is internal to the physical server. In addition, prior to virtualization, most server platforms were dedicated to a single application. With server virtualization, virtual machines share the server's CPU and I/O resources. Oversubscription of virtual machines on a physical server can result in application performance problems because of factors such as limited CPU cycles or I/O bottlenecks. While these problems can occur in a traditional physical server, they are more likely to occur in a virtualized server because of consolidation of multiple applications onto a single shared physical server. ■

Top reasons for purchasing network management products

In a survey of the SearchNetworking.com audience, readers predicted that disaster recovery requirements, increased applications traffic in general, and managing virtual environments would be their top-three reasons for purchasing network management products in 2010.



SOURCE: SEARCHNETWORKING.COM PURCHASING INTENTIONS SURVEY, AUGUST 2009

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The role of performance management in application delivery

The idea of network performance now encompasses application performance. This chapter outlines how to use network management tools to apply an application delivery framework to the IT environment.

IN THE PAST, most IT organizations concentrated their management attention on individual technology domains (e.g., the LAN, WAN, servers, databases, mainframes, etc.) with the assumption that if each of these technology domains is performing well, the applications that utilize these domains are performing well. Unfortunately, this bottom-up approach has not proven to be very effective. To be more successful with the management component of application delivery, IT organizations need to implement a top-down, application-focused strategy comprising

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several functions.

■ Discover the applications

In order to manage application delivery, IT organizations need to know what applications are running over the network. The typical enterprise has hundreds of applications, however. It is impossible to accurately discover hundreds of applications manually. Hence, IT organizations need to implement tools that will enable them to automatically discover all the applications that are consuming network bandwidth.

■ Identify business-critical applications

As noted, the typical enterprise has hundreds of applications. However, not all of these applications are equally important. An IT organization will not be successful with application delivery if it attempts to focus its management attention equally on each application. Instead, an IT organization must use a combination of technology and an understanding of its company's business processes to identify and focus on a small set of applications that are critical to the successful execution of the company's key business processes. IT organizations also must identify other key classes of traffic. Obviously, they should identify malware and eliminate it, and they should identify recreational applications and eliminate or control the use of these applications based on company policy.

Steps to application delivery and performance

- **Discover all applications**
- **Define what's business critical**
- **Write SLAs**
- **Identify key IT components**
- **Establish performance goals**
- **Baseline apps and IT components**
- **Implement problem resolution**

■ Develop service-level agreements

Once the IT organization has identified the company's business-critical applications, the next step is to begin to craft a service-level agreement (SLA) for those applications. The SLA should contain a brief description of each application, some important features of each application, and a set of QoE metrics or performance indicators that correlate well to QoE.

■ Identify key components of IT

After the IT organization has identified a core set of critical business applications, it must identify the key components of the IT infrastructure that supports them. These components deserve a higher level of management attention because if one of them is unavailable or is not performing well, one or more of the company's critical business applications is likely to suffer.

■ **Establish and monitor performance targets**
The IT organization must quantify how the performance of its key IT infrastructure components affects performance of the company's critical business applications. For example, IT must understand how WAN delay affects the response time of a critical application such as CRM. The results of this exercise can help in refining the set of performance indicators used in defining SLAs and can also be used to set thresholds in performance management tools. These thresholds can be used to trigger diagnostic or remedial actions.

■ **Baseline critical applications and key IT resources**
The performance of both an application and the subtending IT infrastructure varies by time of day, day of the week, week of the quarter, and quarter of the fiscal year. Having a baseline to define normal application and infrastructure behavior enables IT to identify anomalous behavior. In some cases, this anomalous behavior reflects an underlying problem requiring investigation; in others, it can reflect a potential security incident or degradation in performance caused by a transient event, such as a user downloading a large file. Having a baseline also enables an IT organization to measure the impact of deploying a new application or making a change to the IT infrastructure.

■ **Implement rapid problem identification and resolution**
Despite efforts to become more proactive, there will always be unpredictable incidents. IT organizations must implement the tools and processes necessary to quickly respond to a situation once it has affected the end user. Part of this initiative is prioritizing troubles based on their potential business impact. In order to detect problems before users are affected, established baselines and performance thresholds can be used to generate alerts automatically and to trigger automated remedial action or diagnostics to help determine the root cause of the problem or potential problem.

As IT organizations go through the planning and implementation phases of application delivery following a framework similar to the one outlined above, it becomes apparent that optimizing applications delivery depends in large degree on the functionality of the application management solutions that are deployed. Therefore, planning an application delivery strategy is tightly interwoven with the tasks of selecting application management and WAN optimization solutions. These solutions must complement one another and provide the right combined functionality to meet the needs of a particular enterprise. ■

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Advanced network performance management capabilities

Today's network performance products do much more than simply monitor packets. This chapter covers advanced capabilities from several vendors that IT professionals can leverage to save time and effort and simplify administration.

IT ORGANIZATIONS CAN leverage many recent advances in performance management to improve the effectiveness of application delivery. In this chapter, we'll describe some of these advanced capabilities. Particular performance management products may be cited as part of these descriptions in order to provide examples of each capability. These instances are provided for illustration purposes and are not intended to be a complete listing of every product that supports a given capability. As an additional caveat, it should be noted that no attempt has been made to judge, nor are we recommending, any cited product as being best in class.

APPLICATION RECOGNITION

Automated discovery of networked applications is a fundamental requirement and the first step of managing application delivery. In addition, performance management systems must be able to identify underlying network traffic on both a flow-by-flow basis and a packet-by-packet basis. This is required in order to accurately track bandwidth utilization and application response-time metrics.

Traditional techniques that switches and routers use to identify applications (such as Cisco's NBAR—network-based application recognition—functionality) rely on parsing the IP packet headers for 5-tuple information. The information is composed of source/destination IP addresses, TCP/ UDP protocol types, and source/destination port numbers. This approach is adequate to map flows and packets to most enterprise

Sample traffic flow

The table shows sample output from a toll such as Cisco NBAR, which identifies application traffic based on IP packet headers. Note the large volumes of traffic attributed to HTTP-URL and unclassified.

APPLICATION/PROTOCOL	PACKETS PER FLOW	% OF TOTAL TRAFFIC
RTP	217	9%
Telnet	158	7%
HTTP - URL	473	20%
FTP	216	9%
SMTP	96	4%
Citrix ICA	360	15%
SAP	216	9%
WinMX	118	5%
eDonkey	220	9%
Unclassifiable traffic	300	13%
Total	2,374	100%

SOURCE: CISCO, "NETWORK BASED APPLICATION RECOGNITION PERFORMANCE ANALYSIS"

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applications where the IP addresses of the application servers can be tracked with relative ease. Several application performance vendors now also use 5-tuple application identification.

This type of Layer 4 application identification falls short when identifying applications such as Skype or Napster that use dynamically selected port numbers, or in differentiating among different tasks that may be performed via a single TCP/IP port number by a single application server. Enhanced application awareness can be achieved with special appliances or probes that can perform deep packet inspection (DPI) to find application identifiers and application task identifiers deeper within the packet payload. In order to perform DPI at the LAN wire speeds required in the data center, these appliances typically need some form of hardware-assisted packet processing.

The Exinda Networks Unified Performance Management solution, which integrates some application performance management functions and WAN optimization in a single appliance, uses DPI to recognize application layer signatures for both enterprise applications and recreational applications, such as peer-to-peer and file sharing. Fluke Networks Visual Performance Monitor Analysis Service Element (ASE) probes also can perform DPI-based application recognition. ASEs are generally deployed at remote sites to monitor how applications are consuming WAN bandwidth.

MULTI-LEVEL VISIBILITY

Visibility is something of an overused term that refers to the ability of the IT organization to access data related to network or application performance at different levels of granularity. The hierarchy of data granularity has a number of levels, including:

- **SNMP MIBs:** Simple Network Management Protocol Management Information Bases (SNMP MIBs) on network devices, such as switches and routers, provide data-link layer visibility across the enterprise network and capture parameters such as the number of packets sent and received over an interface and the number of packets that are discarded, as well as the overall link utilization. However, this level of data aggregates traffic from all applications and cannot be used to identify which network users or applications are consuming the bandwidth.

- **Network flows:** A network flow is defined as a unidirectional sequence of packets between a given source and destination. Flow data from network elements can be collected and analyzed to quantify overall link utilization as well as exploit 5-tuple information to identify which network users or applications are consuming bandwidth. The most popular source

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of flow information is Cisco NetFlow, which is a feature of Cisco IOS software. Most performance management systems can leverage flow-level data from NetFlow and similar data sources. A number of vendors gather and analyze network flow data from infrastructure agents, including NetQoS, Cisco, NetScout, CA eHealth and Lancope. Another set of vendors, including NetQoS, NetScout, Riverbed/Mazu Networks, InfoVista and Lancope, perform collection of this sort of flow data via probes on network taps or mirrored switch ports.

- **Network path data:** The next level of data granularity focuses on gathering performance data relative to end-to-end paths through the network. At this level, a performance management system can monitor an entire end-to-end path in order to determine which elements on the path are responsible for excessive delay or packet loss. Another aspect of path visibility is the ability to track network performance within a VPN cloud or over the Internet. AppCritical, from Apparent Networks, is an example of a performance management application that provides analysis of end-to-end network paths in real time by using non-application-specific synthetic traffic. AppCritical can continuously monitor the capacity and quality of thousands of network paths in real time. This approach can be effective in diagnosing problems or alerting IT staff to possible impending performance shortfalls.

- **Packet-level data:** In order to respond to the challenges of diagnosing problems rapidly and taking preemptive action to prevent potential problems from affecting end users, IT organizations often need the packet-level detail that is supplied by deploying deep packet capture appliances. A typical approach, partly driven by economics, is to rely on management data from SNMP MIBs and NetFlow in small sites and augment this with packet-level detail gathered from dedicated appliances in larger, more strategic sites. The introduction into the market of lower-cost packet capture appliances would allow broader deployment of these devices.

NetScout nGenius InfiniStream is an example of a deep packet capture appliance that can be used in conjunction with nGenius K2 software running on an nGenius Performance Manager server to perform statistical behavior modeling and anomaly detection to the packet-level flow data. OPNET ACE Live and ACE Analyst are other solutions capable of packet capture and analysis. Both of these systems can help to determine the root causes of application degradation.

REAL-TIME MONITORING/ANALYSIS OF PERFORMANCE METRICS

By monitoring metrics such as application response time, availability, latency, jitter, and packet loss and comparing real-time measurements with established baselines and thresholds, the performance management system can issue alerts on performance trends and performance degradation to allow problems to be detected and addressed before they affect end users. For example, gathering application response time data typically requires the deployment of an application-aware appliance in the data center, which may also be able to drill down to measure the response time experienced by an individual user.

The Fluke Networks Application Performance Appliance is an example of a data center device that provides visibility of end-user response times for multi-tiered business applications, with visibility down to the level of individual users and transactions. NetQoS SuperAgent, the application performance management module within NetQoS Performance Center, can monitor every TCP application packet to measure application response time and to identify the network, server and application components of end-to-end latency. (Note that at publication time, NetQoS had entered into an agreement to be acquired by CA.)

In addition to response time, performance management systems can provide real-time monitoring of metrics such as packet loss, latency and jitter that may be gathered either as an aggregate figure for an end-to-end path or at a level of detail that focuses on specific applications or individual user flows. The NetScout nGenius K2 application monitors and analyzes a range of key performance indicators, including response time, packet loss, latency and jitter.

Performance monitoring functionality can also be linked with automated diagnostic capabilities that can leverage visibility into multiple levels of the data hierarchy described above to identify the cause of performance degradation. For example, automated analysis of performance anomalies or degradation trends can result in the resolution of potential problems before they affect users. Examples of performance analysis tools with predictive capabilities include NetQoS's Performance Center Predictive Problem Resolution and NetScout's nGenius K2.

INTEGRATION WITH FAULT MANAGEMENT

IT organizations focusing on application delivery need to improve their troubleshooting capabilities in order to better isolate end users from application shortfalls and to improve mean time to resolution (MTTR) of performance problems and faults. This improvement can be achieved via tight integration of application performance management functionality with fault management. An integrated performance/fault management system is capable of leveraging topology information to automatically perform detailed root-cause analysis to determine a small set of probable

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causes of the performance degradation or fault.

With root-cause analysis, the IT organization can investigate each of the probable causes in parallel, greatly reducing MTTR. For example, HP Performance Insight Software can be integrated with Network Node Manager fault management via automated network lifecycle management. CA is another example of a vendor that provides integrated fault and performance management solutions with eHealth Performance Manager and Spectrum Infrastructure Manager integrated via CA Spectrum Automation Manager.

VIRTUALIZATION

As noted earlier, fault and performance management of physical servers also needs to be extended into the virtualized environment, ideally with a common set of tools. This allows traffic visibility and analysis, topology discovery, event correlation, and root-cause analysis to be just as effective in the physical/virtual environment as they are in a purely physical server environment.

Virtual switches such as the VMware vSwitch can now export NetFlow data to Netflow collectors, providing visibility of network flows among virtual servers in the same physical machine. Performance management products are now beginning to leverage this capability by collecting and analyzing NetFlow data among virtual machines on the same physical platform. NetQoS and Lancope are two vendors with performance management products that provide this sort of functionality.

Another approach to virtualizing performance management is to run traffic monitoring software on a virtual machine or virtual appliance within the virtualized server. This allows monitoring performance for traffic flows of multi-tiered applications throughout the virtual environment. The NetQoS Response Time Virtual Collector is an example of virtual machine software that measures application response time for enterprise applications running in virtual machines. The Lancope StealthWatch FlowSensor VE is a virtual appliance for VMware ESX servers that captures traffic statistics at the flow and packet levels to monitor performance and discover the virtual topology even as virtual machines are moved via VMware VMotion. FlowSensor also enhances security by performing behavior-based anomaly detection of traffic flowing through the vSwitch.

While changes in the virtual topology can be gleaned from flow analysis, a more direct approach is to access data in the virtual server environment's management system. Gathering data from this source also provides access to performance information, such as CPU utilization and memory utilization, for specific VMs. For example, the NetQoS Performance Center leverages the

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VMware vCenter API to extract this sort of information from vCenter. Integrated with CA eHealth Performance Manager and CA Spectrum Infrastructure Manager, CA Virtual Performance Management polls VMware vCenter servers for information that can be used in diagnosing performance problems, fault isolation, and root-cause analysis.

INTEGRATING MANAGEMENT TOOLS

A number of emerging performance management solutions have advanced functionality to help IT organizations cope with some of the challenges they face in implementing a comprehensive strategy aimed at meeting QoE levels for a broad range of business-critical applications.

The product selection process generally involves additional considerations beyond functionality, however. These other considerations include factors such as ease of integration with the existing toolset and overlap with the capabilities of existing tools. Ideally, IT can settle on a relatively small set of well-integrated tools that not only meets the needs of assured application delivery but also can be adopted by all the enterprise's management domains (network, server, application, and networked storage) and hence function as common ground for cooperation and communication.

Another emerging aspect of management tool integration is the integration between WOC management systems and performance management systems. Integration of this sort can potentially benefit both enterprise IT organizations and providers of managed WAN optimization services. For example, Cisco has addressed this area for WAAS (Wide Area Application Services) products through a partnership with vendors such as NetQoS and Fluke Networks, while Riverbed acquired the Cascade network behavior performance management system via the buyout of Mazu Networks. In a third approach to this sort of integration, Exinda Networks has incorporated application performance management as one of the basic features of its WAN optimization solutions. ■

ABOUT THE AUTHOR

Jim Metzler is widely recognized as an authority on both network technology and its business applications. In more than 30 years of professional experience, Jim has worked in almost every aspect of the networking industry. This includes creating software tools to design customer networks for a major IXC; being an engineering manager for high-speed data services for a major telecom carrier; being a product manager for network hardware; managing networks at two Fortune 500 companies; directing and performing market research at a major industry analyst firm; and running a consulting organization.

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