Performance Management in the Virtualization Age

Even though the bubble and its collapse are now history, there is still no question that the information technology and networking markets love slogans or buzzwords, and "virtualization" is clearly one of the hottest. It's also clear that the focus on the slogan and expected value of virtualization may be distracting users from the implications, particularly the implications of virtualization on network and application monitoring, management, and assurance.

Networking has always been about a kind of virtualization. A phone conversation is a virtual form of a physical meeting, and web pages virtualize addresses to URLs and remote servers to local storage. Networks are extenders, ways of breaking distance barriers between users and resources. This has happened in voice communications, and is now happening in video and data services. Each new networked application creates a new network dependency, a new set of interactions between workers or people that are hugely impacted by network failure, and that is why each new networked application has to be addressed with an expanded strategy for monitoring the network to ensure the application is available at required service levels.

Virtualization in the data world, which is the focus of today's activity, is creating a new and special set of network challenges. Distributed computing is decades old, but early computing architectures often linked applications/users and resources directly together in what was called "tight coupling". To take full advantage of the ability of modern networks to distribute resources, vendors and standards groups worldwide have looked for a looser way to couple resources with applications. These new ideas are sometimes called "service-oriented architectures" (SOA), or "virtualization", or "web services", but they are all properly a part of a trend to loosen the binding between resources, applications, and users so that information relationships and applications from the sum of available tools can be composed—anywhere in the world. SOA is thus an extension of the principles of virtualization. Virtualization strategies can apply to any resource, any mission. They're the basis for outsourcing, software-as-a-service, even "off-shoring". The notion of disconnecting specific resources from resource users is simply too powerful, too valuable, not to be expanded.

In fact, virtualization and SOA are critical drivers in what will be the fourth wave of IT spending growth since the end of World War II. US Bureau of Economic Analysis data collated by CIMI Corporation (Figure 1) shows how each of the prior waves has revolutionized information technology and its relationship with networks. Each wave represented a new paradigm in worker empowerment, a new path toward productivity growth.

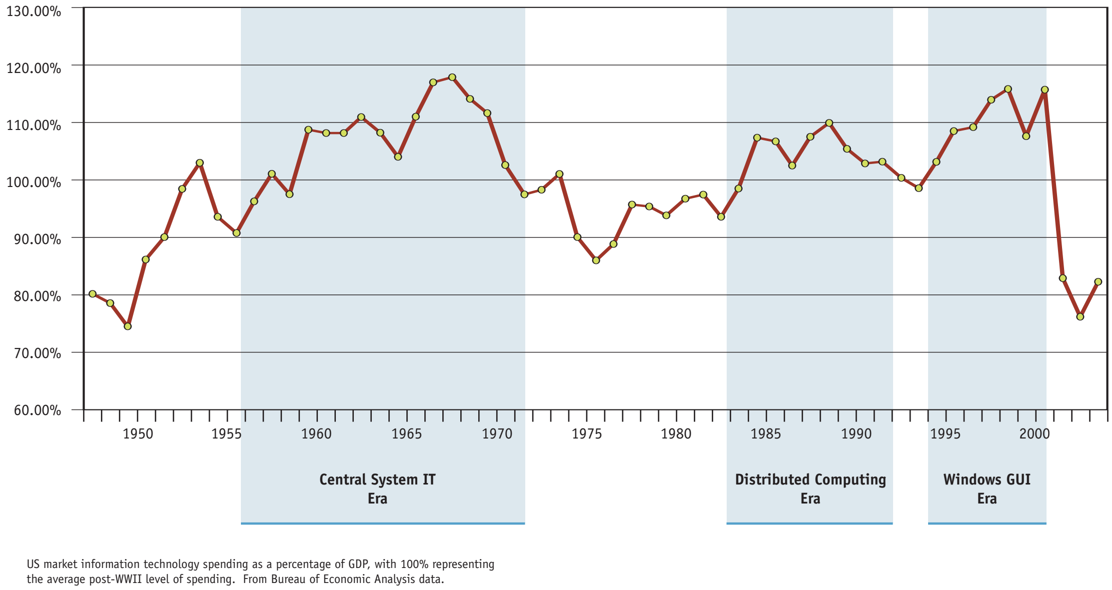

Figure 1: The Ages of Technology

It's not surprising that the kind of spending growth this figure promises is focusing businesses more and more on the critical question of how to assure the availability of the new, distributed, loosely coupled, business resources made up from the collection of modern network technology, modern servers and storage, and modern applications. Historically, IT spending waves are characterized by a growth in investment in the new paradigm that often outruns buyers' ability to manage their new IT framework. While such a "management gap" is always dangerous, it is particularly so with the coming IT wave, because the shortened application development cycles of today are—because of their very shortness—all too easily impacted by deployment and support problems.

Business Week called SOA "the most important—and hotly contested—trend to hit software in a decade"[1]. Cisco's John Chambers, speaking in August 2005, said "Virtualization technologies have allowed businesses to hire the best employees, open offices across the globe more cost-effectively, and not be tied to physical locations. For society, the benefits of virtualization have been perhaps even more significant, particularly with distance learning and telemedicine." "Service-Oriented Architecture has rapidly become an absolute requirement for most enterprises," said Ronald Schmelzer, senior analyst, ZapThink, LLC. SOA and virtualization are on the edge of an explosion, fueled by a boom in IT spending. Virtualization and SOA will literally remake IT, and remake networks as well. Monitoring and management must be remade with them.

The conception of virtualization is changing and expanding, from the Internet model of virtual or logical addresses created by URLs to modern server and storage virtualization and the SOA revolution. In this new age, we'll have to learn to look at networks, servers, virtualization tools, and storage as an application fabric that support applications holistically, not as individual elements. We'll have to look at monitoring and management as a series of organization-specific, mission-specific, and yet fully cooperative processes. The success of virtualization and SOA depends on the success of creating a reliable framework for operational control of this new application fabric.

[1] "SAP: A Sea Change in Software", Business Week, July 11th 2005.

Application Awareness and Application Disconnect

The traditional approach to network and resource monitoring has been from the infrastructure side. Protocols and applications leave visible footprints that can be detected through network probes or system agents, and this data can be collected, summarized, and digested to support problem management and capacity/performance planning. This approach, because it's focused on the network resources, tends to separate resources from their uses, requiring enterprises to manage networks rather than managing network experiences.

For example, the introduction of new types of traffic such as VoIP changed the picture in the network monitoring space because not only does VoIP traffic, for its more demanding performance metrics, need to be considered separately from data traffic, the VoIP traffic supports a completely different organization and budget center—the "telephony" side of the network. At the same time as VoIP came onto the network scene, network operations was contending with increased business needs to monitor specific applications, to understand how network performance impacted not just "data" but specific types of data, some more critical than others, in fulfilling the company's mission.

NetScout responded to the need to understand network experiences and not just network conditions by focusing on flows, rather than devices, and by application- and user-oriented views and reporting. These created a two-dimensional view of networks, a view based on resource state and a view based on the network experience applications and users were obtaining. Over the last several years, the success of the *nGenius* Performance Management approach has demonstrated a simple truth; new monitoring and management missions augment, not replace, existing ones. Network usage is broader today, and so management scope must be broader and not just different.

We are now entering yet another new age, and the mantra of resource and network monitoring and management in this new age is "application awareness". It's just logical to assume that since applications are the consumers of resources, whether they are servers, storage, or services, the process of monitoring and assuring resources has to start at the application level. In fact, SOA proposes to create a whole new "application layer" in a literal sense.

SOA is normally implemented using a set of standards called "web services". The web services-enabled SOA framework is based on the concept of a publish-and-subscribe intermediary directory that lets users find component services to satisfy the mission of each worker, and bind those services into a collection of features that behave like a single application. This binding process seems a logical way to focus management and monitoring at the real issues, which are how networks and resources support applications, and through them business processes.

However, virtualization breaks the applications' link to resources. The basic principle of virtualization is to create an "intermediary" between the user or application and a resource, an "intermediary" that is then independently mapped to the "real" resources. This step allows flexible resource assignment and management, but it also means that the resource view of an application is deliberately "false". A virtual disk may appear to an application as a real disk drive, but actually be spread over a dozen volumes in a dozen different locations.

Virtualization creates, at the network level, a challenge to traditional "application-aware" management approaches. SOA and web services create a new protocol layer, a layer that is so independent that the new layer can theoretically ride on top of any other protocol. With the existence of this new protocol layer, so independent of today's IP network that it doesn't even rely on IP, how can network and application management solutions gain access to network data needed for problem diagnosis and resolution?

Application Fabric Defined

A critical first step in solving the problems that virtualization and SOA pose is recognizing that these new concepts blur the distinction between "resources" like servers and applications and "resources" meaning network resources. In the new age of virtualization, how you get to something and what that something is are interrelated, and this has to be reflected in a new view of resources and information about resources, a view we call the *application fabric* which is illustrated in Figure 2. The *application fabric* is the set of interconnected virtualized resources implemented over the physical infrastructure (servers, network, and storage) shared by both traditional and emerging applications. While traditional applications are typically based on a simple client-server model, emerging applications are increasingly more distributed and multi-tiered.

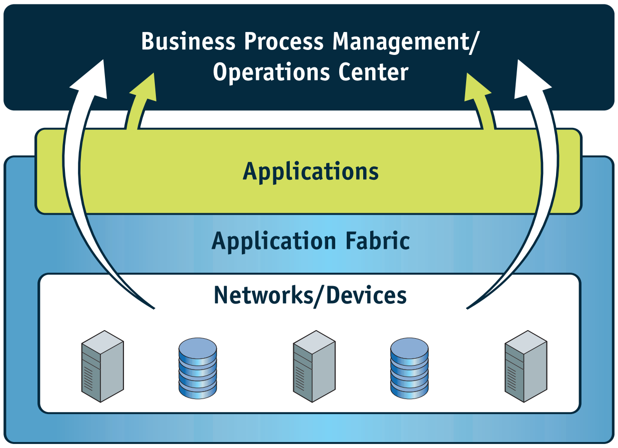

Figure 2: The Application Fabric

The operational status – "the health" – of the elements in this fabric represents the health of the IT, network, application, and content elements needed for successful and profitable business operations. The fabric also includes SOA and virtualization tools, so the view of resources developed from the bottom fabric level and projected upward to management of network and IT operations is a complete view, one that can really incorporate an application view. The network—the resources—are made application-aware.

The application fabric contains the following specific resource components:

1. Server resources that host applications and control storage relationships.
2. The network resources that support application and user information flows.
3. Storage resources that are part of a network-distributed storage system such as NAS or SAN.
4. The virtualization "middleware" tools and processes that provide such things as publish-and-subscribe directories and server/storage mapping.

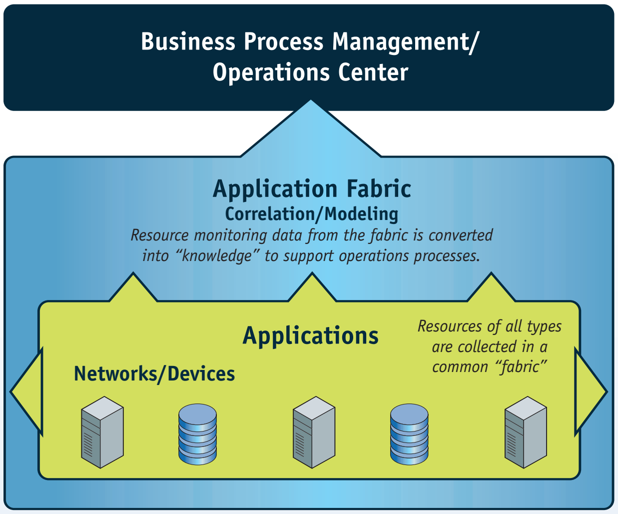

Figure 3: Application Fabric and Knowledge Creation

The application fabric viewpoint offers a unified framework for monitoring and management, one that permits both problem determination and capacity/performance planning. Resource information collection from the application fabric must offer an integrated view of everything on which applications depend, a view that (as Figure 3 shows) is derived from the application fabric, including a holistic vision of virtualized resources and SOA. This integrated view is the starting point for developing knowledge from information.

Management Requirements

The difference between “information” and “knowledge” is very important. Resource information is a set of statistics that describe the present and past behavior of a resource and define its current operating state. Resource knowledge is the understanding of the present and future ability of the resources to fulfill their business mission. Normally, “knowledge” is created by human analysis of information, and trends in more graphical interfaces for monitoring and management systems have been aimed in large part at reducing the effort required by the operations center staff in creating knowledge. There is no question that effective and targeted resource reports and views are critical in supporting knowledge generation by inspection, but there is also no question that the growing mass of data threatens to swamp human senses, and thus even the ability of experts to assimilate information and convert it to knowledge.

We need new tools for knowledge creation providing multiple management views customized to the mission of the user. The goal of any management strategy is to support differentiation between conditions which require no action and problems which must be remedied. A problem may be a fault that requires immediate action or a utilization trend that requires planning and selective resource investment. NetScout’s approach to application fabric performance management provides the knowledge-building needed for this differentiation, and other aspects of NetScout’s architecture support extending this knowledge to various system and resource management tools to empower operations centers to remedy, through intervention or planning, whatever problems arise. This supports both a reactive management policy where problems are addressed as they occur and a proactive policy where resource consumption trends are analyzed to provide early detection of problems and address them through rapid problem resolution. We call our approach Application Fabric Performance Management (AFPM)

The Path to AFPM

AFPM directs information collected on resources to support both intervention to address service failures and intervention to reverse adverse trends. It supports a top-down view based on user experience, and a bottom-up view based on resource state and capacity planning. This illustrates a basic truth, which is that resource information is independent of application, and that resource knowledge must incorporate an understanding of the goals of the information user, not just the status of the resources. The first step in creating AFPM is organizing resource and network information in a user- and use-centric way for creating knowledge. Resource knowledge is based on two key mechanisms for extending the value of resource information—correlation and modeling. Figure 4 shows how the process of knowledge creation relates to the concept of the application fabric.

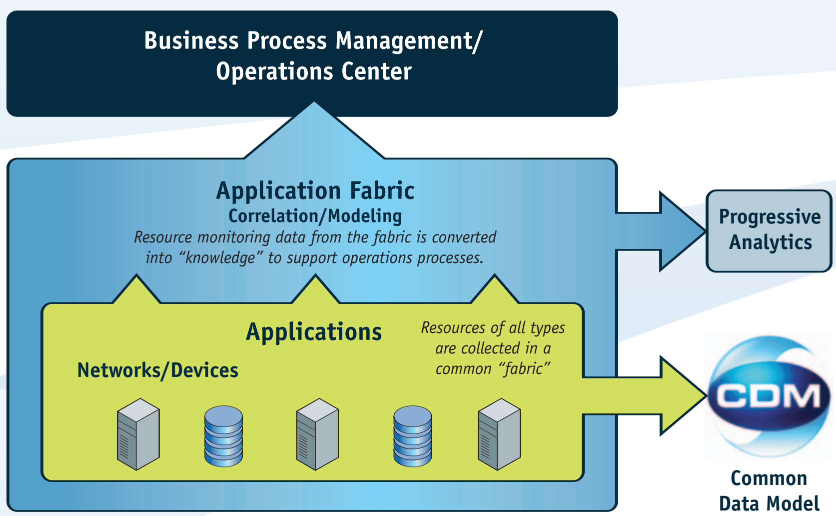

Figure 4: Analytics Extends Knowledge

NetScout's approach to knowledge-building is based on 4 simple principles:

1. Information is the basis of knowledge, and so a first priority is to gather information about all of the resources in the application fabric and store it for analysis and use.
2. Knowledge-building must consider information from the past and the present equally. Simply correlating real-time events is not sufficient; you must correlate historical events as well.
3. The most value you can gain from analysis of the past is the ability to model and predict normal and expected performance for the present and future.
4. Knowledge is in the eye of the beholder; the specific needs and biases of the users of knowledge must be considered explicitly in the creation of knowledge.

NetScout's network and application performance monitoring has long been based on the concept of a Common Data Model (CDM), an framework for flow-based performance metrics that could be extended to accommodate the new types of traffic, devices, links, protocols, and applications that have combined to create the network-dependent business services of today. With the advanced concept of the application fabric, NetScout is extending its CDM to support the integration of performance and status information from system, storage, and application resources.

All of the information in the CDM is available to apply Progressive AnalyticsTM for correlation and modeling purposes. The fact that Progressive Analytics operates equally on past and present data, systems and network data, offers a number of important benefits:

- Correlation and modeling can take into account both information on network traffic and on system/application performance and status. Since virtualization and SOA mingle the behavior of both to create a user experience, this is a critical benefit.
- Correlations can span both real time and historical information.. This is critical because many network/system interactions that either create problems or offer symptoms of abnormal behavior are not synchronized in time because one condition is the cause of the other. Event-based fault correlation may miss these key dependencies because it operates only on real-time data.
- If unexpected problems occur, historical data covering the entire application fabric enables better post-mortem analysis.
- Past behavior is 'learned" and compared to present data to serve as the basis for anomaly detection.
- Multiple views of information can be created from a common repository, each with their own correlation and modeling tools included.

The points above not only illustrate the value of complete information, they illustrate the value of analytics. Historical data, in and of itself, is of interest primarily to historians. The ability to model the normal state by analyzing trends developed in the past is one step from information toward knowledge, and NetScout's Quantiva acquisition adds the best analytics in the market to the most comprehensive Common Data Model. The result is unparalleled ability to spot trends, detect anomalies and focus problem resolution.

Progressive Analytics has three primary thrusts:

1. The modeling and analysis of real-time and historical data to create a statistical baseline for the behavior of the application fabric and its elements. This baseline can then be used to uncover behavior anomalies and to focus further diagnostic review.
2. The modeling of resource states based on the combination of current data and historical trends. This supports valuable trend analysis to spot problems before they fully develop.
3. The filtering of "conditions" into "alerts", meaning the analysis of data trends to separate those that have operational impact from those that do not. This improves operations efficiency by reducing the number of "false positives" that must be reviewed.

Application Fabric Performance Management Implementation

While the application fabric will be continually made more robust via faster network connections, more powerful servers, and application accelerators, such infrastructure upgrades alone will be insufficient to ensure service levels in the new environment due to the fact that they must all be coordinated in ways that each cannot be individually aware. In this same vein, a new performance management approach is also required. Today's performance management tools were designed for traditional applications deployed on client-server infrastructure and thus are narrowly focused on the servers, the applications, or the network. Further, they are overly dependent on the human operator/user to detect and correct performance problems. The result is that takes too long to detect, isolate, and resolve performance issues in emerging application fabric environments.

NetScout will deliver new solutions, based on the AFPM architecture, to mitigate these shortcomings by monitoring the behavior of applications in conjunction with their underlying fabric resources. Defined within AFPM is NetScout's solution to the creation of information hierarchies based on the concept of Analytic Domains™. As Figure 5 shows, an Analytic Domain collects element performance metrics that describe the state and activity of all of the resources used to support users and applications, and fabric performance metrics, the combination of application flow data that describes information movement between users or between client and server, and the quality of experience data that directly measures response time and observed service stability. This information, representing all of the factors that impact the way that resources, users, and applications interact, is selectively recorded, analyzed and correlated to produces real time knowledge of application fabric behavior and status.

Analytic Domains will commonly support the mission of a user or using organization. Most companies have support organizations, but just exactly how these groups are structured and how various technology resources are assigned to groups will vary widely. Analytic Domains adapt to any organization, any support policy, any operations practices.

Analytic Domains couple performance information through the Common Data Model to the analytics process. These are then combined for a comprehensive view of application fabric performance, and presented to the user through a sophisticated set of graphical user interface and reporting options, and to third-party management and control systems via alert and data export functions.

Analytic Domains provide a way of organizing information to match the real world organization, focusing knowledge creation on the mission of the experts who will use that knowledge to manage the applications that justify the network and empower the enterprise.

It has been an industry practice to collect network and system information using "probes" or "agents", which are software processes that can monitor resource status and communicate it to a higher-level set of data storage, analysis, and display tools. NetScout's Analytic Domain technology adds an additional level of distributed intelligence to the normal process of information access and analysis.

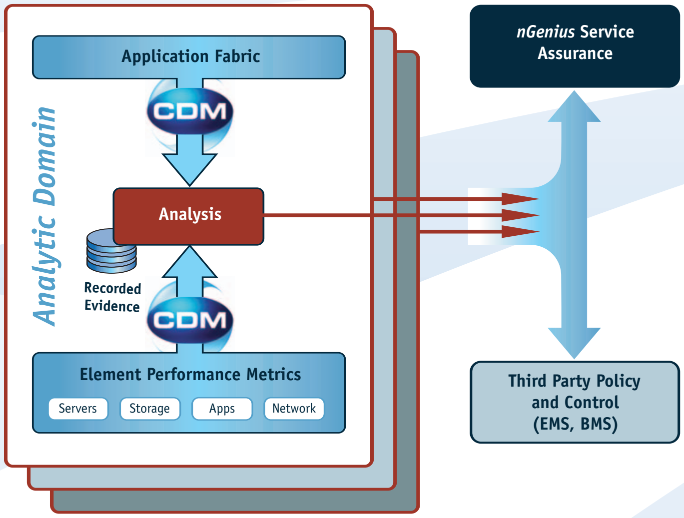

Figure 5

NetScout has long supported a distributed information collection and analysis architecture in its nGenius Performance Management System products. This allows for the distribution of information gathering, reducing network activity and cost, and also creating a scalable platform for very large network monitoring tasks. Analytic Domains are an extension of this proven approach with the addition of distributed real time analytics and distributed evidence collection and storage. Analytic Domains integrate all of the capabilities for building network and resource knowledge, and provide for scalable real time performance management in the application fabric.

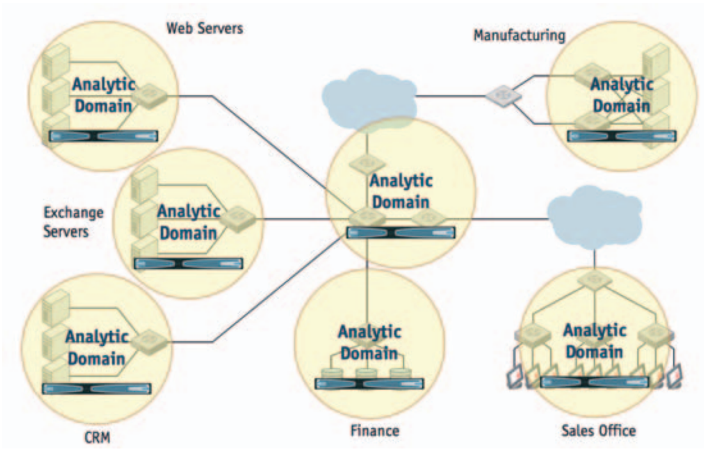

Figure 6

As building blocks of NetScout's AFPM solution, Analytic Domains will give operators a major head start in preventing or resolving service disruptions, leading to significantly reduced MTTR (Mean Time To Repair) by:

1. Continuously monitoring and automatically detecting performance problems on designated applications and business services
2. Performing automated diagnostics for initial isolation of the likely root cause in the application fabric.
3. Providing real time notification on the detected anomalies and root cause along with the identification of the impacted business services in collaboration with business partners
4. Delivering detailed information, including recorded application flows diagnostic tools, for subsequent in-depth troubleshooting and forensic analysis as needed
5. Reporting historical trends on the monitored metrics for validating problem resolution, for performance tuning, for resource planning, and for documenting service levels.

The Analytic Domains are linked to form NetScout's AFPM architecture set shown in Figure 6. This collected knowledge is then available either to an nGenius System GUI/reporting capability or to third party enterprise consoles via the Common Data Export (CDE) capability.

The knowledge distribution through the CDE is critical to the effective support of applications and networks. While the gathering of information about network and resource behavior is a general function, and while knowledge-building is valuable independent of the specific way that users might want to exploit that knowledge at the operations level, there are in fact many tools and many strategies for converting knowledge into action. Some users will employ vendor-specific network management tools, others will use high-level "manager-of-manager" products to integrate their view of their resources and centralize their management processes. Some will manage application resources from a single operations center and others will have multiple centers distributed by geography, type of resource, or even vendor. NetScout believes that the process of resource monitoring cannot constrain the way that the information being gathered is used, and so supports a general set of APIs to present information from one or more Analytic Domains in the format required by higher-level management tools.

Through CDE, NetScout supports the attachment of a wide variety of higher-level tools that can be used to distribute information, integrate knowledge into various management platforms, and exercise resource control. Since the view of the application fabric is divided by Analytic Domains, this distribution of information can easily partition responsibility for various resource types (e.g. network, system) or integrate the entire control/management/monitoring process into a single operations center.

Conclusion

The greater reliance placed on networks today, and the interdependence between network and server/storage, middleware, and applications that is created by virtualization and SOA, has greatly increased the complexity of network and resource management. This has driven enterprises to look for an easy and logical way of linking the performance of their applications to the performance of their resources. The terms "application-aware networking" and "application performance monitoring" reflect the marketplace's response to this enterprise goal.

Application-based monitoring is a good way to drill down from a reported problem to find its cause—the "reactive" or fault management view. However, that drill-down must somehow accommodate virtualization's impact on resource and network knowledge. Application monitoring is an insufficient way to provide knowledge of traffic trends that drive network and resource planning, the "proactive" management view.

IT should not have multiple management approaches that address the same users, resources, networks, and needs. IT also can't have an application resource monitoring strategy that fails to accommodate the different monitoring, planning, problem resolution, and support centers that have developed over time. Some companies will expect to retain their current management tools and staff in place; others may want to consolidate multiple management silos. The correct solution must let companies organize application resource management and monitoring any way they like. But whatever the management strategy, there must be a knowledge-building element added to deal with the complexity of virtualization and SOA.

NetScout believes that the key concept that solves the problems of monitoring and management today is a collection of information-gathering and knowledge-building tools that together define the scope of a problem in a resource sense and at the same time recognize the organizational scope of its solution. Analytic Domains are NetScout's flexible building-blocks that deliver what each operations support group must have, and collect the information from each of these support areas for summarization into other areas for fault correlation, as well as up the management chain and even to the end user. This architecture creates a flexible resource management and monitoring, not only at the level of the GUI but at the resource, geographical, organizational, and interest profile levels.

Application-oriented networking, virtualization, application monitoring, service oriented architectures, web services...there are many new terms in the network and resource operations space today. Naming them may offer some comfort, but it doesn't necessarily lead to tangible results, and in fact there is a strong argument that "application monitoring" is being viewed as somehow a successor to traditional monitoring, when nothing could be further from the truth. The truth is that virtualization and SOA and other "loose coupling" trends create a new need for application awareness in monitoring and management, but they also increase the need for traditional monitoring and management.

Virtualization decouples applications from resources and makes it more and more complicated to manage resources by managing how each interacts with applications. At the minimum, a modern monitoring strategy for a virtualized resource set must provide both for the association of applications with the real resources they are using, and the management of resources as a pool of technology, a well from which applications may draw to fulfill their needs. This is what NetScout calls Application Fabric Performance Management.

However the process of virtualization evolves, and however focused users may become on looking at resources through the applications that consume them, it is still a fact that a virtual resource has no real properties, no real hardware, and there is thus no way to service it. Even in virtual networks, virtual server pools, or virtual storage arrays, the problems are real. Only real information, digested into real knowledge, can address them.

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