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Five Ways to Ensure Your Virtualization Initiatives Effectively Support Applications and End Users

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INTRODUCTION

As organizations grow and evolve, they must implement technology changes to accommodate evolving infrastructure needs. These changes are often implemented within complex systems running business-critical applications. Usually, there is also an increased demand for shared hardware and software resources for cost savings. To manage this demand, many companies establish virtual environments.

According to Gartner, "virtualization is the highest-impact issue changing infrastructure and operations through 2012." In the report, *Virtualization Changes Virtually Everything*, Gartner notes that "roughly 90% of the server market is composed of x86 architecture servers. Based on a traditional model of one application per server, roughly 80 – 90% of the x86 computing capacity is unused at any one time."[1] Server virtualization can leverage this unused capacity for other purposes while helping to optimize data center power, cooling and space. Also, Server virtualization offers these potential benefits (see Figure 1).

Increased by Virtualization	Reduced by Virtualization
Business continuity and disaster recovery	Downtime
Flexibility and agility	Utility costs
Server consolidation	Data center space

Figure 1: Key benefits of virtualization

Many organizations that implement virtualization do not fully realize these benefits. Their efforts are hampered by poorly performing applications that fail to meet service levels and the needs of end users. Moreover, what is true in the physical world changes dramatically in a virtual environment, creating new operational and management challenges.

This white paper seeks to help application owners, operations managers and data center managers ensure their virtualization initiatives effectively support applications and end users.

UNDERSTANDING THE GOALS OF VIRTUALIZATION

Following years of growth and change, most organizations have many specialized physical servers and workstations that remain underutilized. Virtualizing such an environment increases and balances utilization by consolidating the physical machines into a single physical host that runs multiple Virtual Machines (VMs).

The VMs share the core four resources—CPU, memory, disks and network cards—of one physical host. The physical machines continue to do the same work, but now with greater efficiency. The host runs a layer of virtualization software, called the hypervisor, which manages the environment. Each VM's operating system (OS)—usually Windows or Linux—functions as if its hardware were physical. Guest software can see only *x* processor, *y* memory and so forth.

A virtual infrastructure affords maximum flexibility, allowing you to treat VMs as if they were physical hardware and software. They can be run in isolation or in groups, and their workloads can be reconfigured as demand requires, based on the ability to move VMs easily between hosts. This flexibility is supported by management tools. VMware Virtual Center and ESX Server are, respectively, the management server and hypervisor components that lend order to flexibility in a virtual environment.

As a management server, VMware VirtualCenter facilitates the configuring and provisioning of all VMs. The VirtualCenter database stores all of the shared information between the physical hosts and the VMs. Without compromising security, VirtualCenter makes it possible to connect to a host remotely from a standard Windows computer.

As a hypervisor, ESX Server allows you to establish VMs, configure and manage their shared resources, and make ongoing adjustments to increase performance. Each VM is configured with its own virtual hardware—for example, central processing unit (CPU), random access memory (RAM), and universal serial bus (USB) ports. The work of the VM's physical counterpart is run in its native OS. Because VMs require neither redundant hardware nor physical space, virtualization can mean significant cost savings in terms of square footage, and, some claim, power consumption and maintenance.

The transition from physical to virtual is seamless when looking at the functionality of the virtualized workloads, but it is not without some challenges. To achieve optimum utilization in a virtualized environment, organizations must do a good job of maintaining the environment. This means data and other assets must be monitored, protected and preserved.

Many of the challenges organizations face in managing applications in a virtual environment can be attributed to how virtualization technology leverages the core four resources: CPU, memory, disk and network. By understanding the impact of resource sharing, as well as gaining insight into the key components of the virtual environment (e.g., data centers, data stores, clusters, resource pools, ESX servers and VMs), organizations can better understand the relationships and interactions between applications and the virtual environment. This ultimately can help organizations determine the root-cause of incidents more quickly, as well as achieve application performance and service level objectives.

OPERATIONAL CHALLENGES INTRODUCED BY VIRTUALIZATION

Today, IT is faced with addressing two primary challenges with respect to virtualization initiatives:

- Understanding how the core four resources (CPU, memory, disk and network) support the application infrastructure (Figure 2).
- Managing the impact of poor performance on applications and end users.

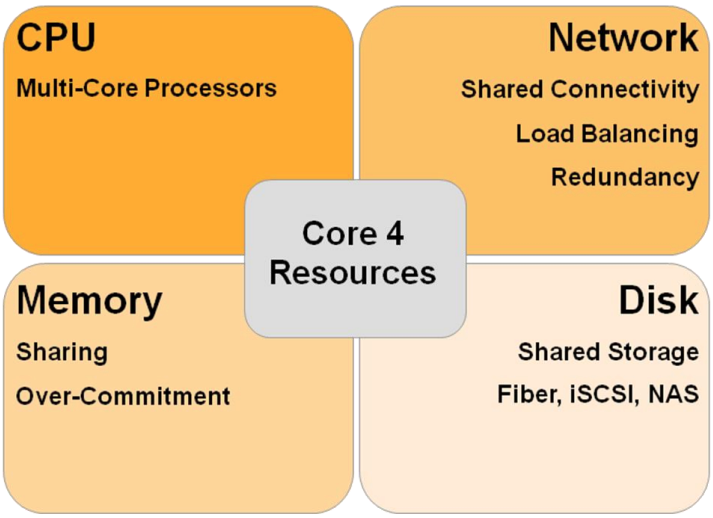

Figure 2: The core four resources of a physical or virtual infrastructure.

For their CPU resources, organizations have adopted multi-core processors to help drive consolidation and the virtualization of enterprise applications. Today, a data center might contain virtual servers that are on par with a server that historically had eight physical processors—not to mention a very high price tag. This amount of processing power drives increased consolidation ratios per physical server, thus driving the need for a better understanding of how the hypervisor is scheduling its available CPU resources.

Beyond the fact that multi-core processors are available, hardware vendors are adding virtualization-specific functionality directly to the processors themselves. Intel VT and AMD-V technologies are lowering virtualization overhead (the amount of resources required to simply run and manage virtualization). As these technologies continue to mature in the virtualization space, expect even greater ROI from your hardware investments.

Given that some hypervisors share memory across multiple VMs, an over commitment of resources is a strong possibility. It is not uncommon, and is actually considered best practice, to over-allocate memory resources to your VMs by 33 – 50 percent. Specific hypervisors can allow this to occur often with no impact to the application workloads that they are supporting. It is important to understand when you cross the line between getting the most out of your memory and pushing the limits too far, to the point that VM workload performance suffers.

The disk is often the most costly resource within the virtual infrastructure. Although lower-cost storage options now exist, such as iSCSI and NAS, performance can be a tradeoff. The storage environment in a well-planned virtual infrastructure can often support dozens of hypervisor host servers and thousands of VMs. By understanding the utilization trends of both the hosts and the VMs, organizations can better determine what impact high disk I/O in one portion of the virtual infrastructure will have against the other workloads in the environment. Adding to the complexity is the need to understand what disk resources the physical server infrastructure leverages and how both environments (virtual and physical) can impact each other.

Organizations often run multiple VMs on a single host, and these hosts frequently share a small number of network connections. This presents a change for the network. Even with load balancing and redundancy in place, some organizations find that virtualization has a negative impact on their application service level agreements (SLAs). It is important to know not just how much traffic is being sent over the network, but also what type. Workloads that have a high number of small transactions will often require more CPU resources than workloads that generate a lower number of large transactions. The ability to track and map these characteristics across the various core four resources is valuable for ensuring optimal performance from a virtual infrastructure.

Several challenges prevent organizations from reaping the benefits of virtualization and attaining their application service levels or performance objectives.

Clarity

Virtualization introduces a layer of abstraction never seen in physical server infrastructures. This can reduce the visibility of the multiple resources running concurrently across the many layers of the virtual environment.

Native tools like VMware VirtualCenter, along with existing monitoring tools, show data in many tabs, making it confusing to determine the root-cause of an incident or problem. Furthermore, disparate management servers require independent administration and, thus, several mouse clicks to view the proper data. Still, none of these tools puts this data into context, showing how it relates to what is occurring in the infrastructure.

Additionally, data trending is not given much weight in traditional virtualization monitoring. Sudden increases or decreases in utilization that stay within the bounds of a threshold will not be detected by these monitoring systems. However, such fluctuations could indicate a larger issue that should be investigated.

Expertise

Virtualization introduces new and different technology. Some of today's hypervisors, like those from VMware, collect a lot of metrics. However, they offer little documentation or context. Even if the metrics are understood, they don't provide information about an existing problem, the reason it is a problem, or any guidance for fixing it. Some organizations turn to external consultants, but as you can probably guess, virtualization experts are expensive and sometimes prove to be an unreliable source of knowledge.

VM performance issues can occur as a direct result of problems within the VM itself or the underlying platform. Problems within the underlying platform can be caused by consumption of a resource by other VMs running on the same underlying platform, or issues involving priority and allocation of a resource to the VM. In addition, VMs can be moved readily from one host platform to another, and this, too, can cause performance and availability issues.

Statistics captured inside VMs for rates (e.g., bytes per second) and resource utilization (e.g., CPU utilization) is unreliable and often misleading. This is because a clock second inside a VM varies in duration and does not match a clock second in the physical or real world. Measuring utilization is challenging mainly because there are no minimum and maximum allocations. This is further complicated by priority, which the virtualization system uses to allocate a resource. So, now you need to understand what that percentage is based on.

Worse still is the fact that the performance of a VM and its application components can very much depend on the performance of the rest of the virtual environment. Therefore, it is important to have a monitoring solution that can identify which physical server a VM is running on, as well as any other VMs that are running on the same server at the same time. A higher priority VM that is taking up more than its share of physical resources may be the cause of the performance problems in other VMs.

Many organizations try to use traditional operating system and application monitors with a VM. However, the metrics they provide are often inaccurate due to the complexity of factors such as dynamic resource scheduling, live migrations to alternate hardware, and time-keeping issues inside VMs.

Containment

The architecture of VMware is new to many people, and this creates an interesting issue for alarm storms. For instance, you could receive an alarm at the physical server layer that triggers alarms for all the associated VMs. So, which alarm should you look at first?

Traditional monitoring tools fail to understand the correlation between infrastructure, host or VM issues, and with the snowball effect that can happen, the result can be an alarm storm. This forces IT to first work to prioritize the problems and then determine how best to troubleshoot the issue. Meanwhile, performance degradations or availability issues could be affecting end users.

Tracking

The introduction of Live Migration, as well as the advancement of High Availability technologies, has made tracking VM movement more critical to understanding performance management. Traditional monitoring solutions make it very difficult to track the occurrence of a migration as it relates to changes in VM performance.

Efficiently judging what will happen to a particular host or VM prior to a manual migration is a complex challenge, and traditional tools do not have the necessary analytics to determine what should happen based on previous trends.

Imagine a very heavily-used ftp server trying to coexist on the same physical hardware as a heavily-used web server. You can guarantee that the traffic to/from one will impact the performance of the other. Changes to the shares allocated to one VM changes its performance relative to all the others on the same physical server. An increase in resource consumption by one VM can adversely affect the performance of other VMs on the same physical server. A VM with a runaway process might impact the other VMs on the same physical servers. Moving such a VM using VMware DRS will likely impact the other VMs on the target.

Prevention

Portability of VMs provides huge benefits, but also can introduce risk. Before performing a Live Migration, administrators need all the information possible about the core four resources discussed earlier, along with an understanding of growth trends.

Traditional monitoring tools do not have the capability to accurately measure and alert on SLA thresholds built around a virtual infrastructure. A pragmatic approach to monitoring is needed to help you understand configurations and patterns—and ultimately enable you to be more predictive and leverage automation in managing your data center.

In total, these challenges vary in significance based on a variety of factors and can be compounded by the number of VMs in the environment; the number of administrators provisioning VMs; the lifecycle or movement of VMs within the datacenter; or the need to understand the impact on the core four resources before a planned or unplanned change.

Most importantly, organizations that are running business-critical applications on VMs must carefully mitigate these challenges, or otherwise risk missed service levels or poor end user experiences.

EFFECTIVELY SUPPORTING APPLICATIONS AND END USERS

Effectively managing applications that leverage a virtual infrastructure can be an elusive goal. However, the aforementioned challenges can be addressed by better understanding the virtual infrastructure and by managing the relationships and interaction between all the components in the virtual environment. Ultimately, being able to correlate the events occurring in the virtual infrastructure with the entire application environment helps you determine the root cause of incidents and can reduce mean time to resolution for incidents and problems.

Let's review the five ways you can better ensure that your virtualization initiative effectively supports your application and end user satisfaction objectives.

1. **Better understand how the virtual environment impacts the entire application.**
   Visualizing the entire virtual infrastructure in a single view allows you to clearly see the multiple resources concurrently in use across the many layers of the environment, including data centers, data stores, clusters, resource pools, ESX servers and VMs. What's more, being able to correlate the events occurring in the virtual infrastructure with the entire application environment helps you determine the root-cause of incidents in the virtual environment and reduce mean time to resolution for incidents and problems.

2. **Determine the root-cause of an incident or problem before end users are affected.**
   The key to determining the root-cause of an incident or problem is expertise. Thus, IT needs detailed alarms with recognized industry expertise covering best practices, future predictions, deviations from normal activity, and specific operational problems.

   Tools that can help you determine that there is a problem, convey why it is a problem, and recommend ways to resolve the problem are ideal for diagnosing and resolving issues before they impact end users.

3. **Track movement of VMs to understand their potential impact on applications and the business.**
   Organizations need to be able to track assets, both in terms of changes to configuration and location, so they can assess the impact of the changes on performance and availability of the dependent application—and on other VMs in the same physical environment. By tracking the movement of VMs, you can better understand their impact on applications and end users, as well as determine what happened and why.

4. **Contain alarm storms from VMs and physical servers for a prioritized IT response.**
   By effectively containing alarm storms and turning data into meaningful information, IT can better understand the correlation between infrastructure, host and VM issues. This is an essential tactic for prioritizing problem-resolution efforts and preventing application performance issues that can lead to a poor end user experience.

5. **Identify contention for resources between VMs to prevent over-commitment of resources.**
   Organizations need to be able to show the resource impact of moving a VM image from one physical system to another. Using this information, they can determine in advance whether planned moves will unfavorably impact resources, applications and end users.

   Additionally, gathering performance and utilization data at several levels—infrastructure, host and VM—will help identify contention issues. By having a clear understanding of the core resources and historical trend information, organizations can prevent future problems and proactively plan for the future.

   As we have established, virtualization offers multiple benefits, but also introduces many complexities. Through these five techniques, IT can more effectively support application and end user satisfaction objectives.

TAKING A PRAGMATIC APPROACH TO VIRTUAL SERVER MANAGEMENT

According to Gartner, "virtualization management technology across almost the entire functional spectrum is relatively immature, and there's an implicit indictment of many of the classical management tools as potentially inappropriate to support this new environment."[2] Virtualization creates a fundamental challenge for organizations in terms of systems management strategies. Most traditional monitoring tools give you a picture of the IT environment, but the rules, policies, scripts and reports that form this picture are hardcoded and static. As the environment grows or changes, the administrator must manually keep all of these configurations up to date. In addition, when new servers come online, or new services or applications are deployed, the administrator must manually add them to all of the existing management policies. The cost and likelihood of human error during these processes can have far-reaching consequences. This introduces additional complexity to those obstacles highlighted earlier and greatly compounds the challenges facing organizations that are focused on moving to and managing a virtual infrastructure.

By simultaneously understanding the virtual environment and the applications that leverage it, organizations can gain the benefits of virtualization while effectively supporting applications and end users. Managing applications and services now, and as your IT environment changes, is essential to aligning critical applications to business service goals, improving application performance, mitigating business risk and lowering IT operational costs.

CONCLUSION

As the emerging leader in virtual infrastructure management, Quest helps customers use virtualization to address and solve an array of challenges related to server consolidation, business continuity, compliance, desktop management and service operations management. With its Foglight solution, Quest helps customers ensure that their virtualization initiatives effectively support applications and end users.

Foglight is an application management solution that reduces or eliminates service disruptions to unify IT and the business. Unlike other offerings in the market, it provides a correlated, 360-degree view of your applications from end user to database, and from service levels to infrastructure.

Foglight helps organizations understand the virtual infrastructure by managing the relationships and interaction between all the components in the virtual environment, including data centers, data stores, clusters, resource pools, ESX servers and VMs. With Foglight, IT can correlate the events occurring in the virtual infrastructure with the entire application environment, helping you determine the root-cause of incidents and problems while reducing mean time to resolution.

To learn more about how Foglight can help you effectively manage applications and end users, please visit www.quest.com/foglight.

ABOUT THE AUTHOR

Scott M. Herold is the Lead Architect for Virtualization Solutions at Quest Software. Scott brings a decade of relevant industry experience in operating system, network, security and storage design. Scott has been a pioneer in architecting advanced virtualization solutions for many Fortune 100 organizations in R&D and implementation roles. He is one of the co-authors of the best-selling *VMware ESX Server: Advanced Technical Design Guide* and the upcoming *VI3: Advanced Technical Design Guide*. He often contributes white papers and articles to online publications focused on virtualization, and he has been recognized on numerous occasions for his contributions to the VMware and the virtualization community.

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