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Tackle the Challenges of Virtualization Management

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Executive Summary

Many IT organizations have embarked on initiatives to virtualize their enterprise infrastructures in an effort to reduce costs, improve efficiency, and reduce energy consumption. In particular, server virtualization is a significant part of any "green" IT initiative. It not only helps reduce server sprawl, but it also provides the ability to quickly meet changing business and workload conditions. According to Gartner, the installed base of virtualized machines will surpass four million by 2009, up from just 540,000 in 2006.[1]

To tackle the challenges of virtualization, you must do more than simply migrate services from physical to virtual assets. You must control the full lifecycle of virtualization in your data center — from planning to configuration to management — across a broad range of virtual and physical server technologies. This approach makes it possible for you to develop, implement, and maintain your virtualized environment in a way that ensures high service quality and agility, without sacrificing management control or regulatory compliance.

Effective planning involves optimizing the assignment of virtual servers to physical servers. This strategy maximizes the use of physical resources while maintaining service performance and availability. The right approach to configuration involves dynamically provisioning virtual servers to physical servers without violating corporate policy or regulatory compliance. Effective management means maintaining the virtualized environment at required levels of performance and availability.

Each of these three areas — planning, configuration, and management — presents a challenge. Virtualization adds a whole new level of complexity to the IT infrastructure that necessitates an evolution of service management processes and solutions. These processes and solutions must be "virtualization enabled." This means that they must be evolved not only to tolerate the virtualized environment, but also to enable IT to exploit virtualization to its full potential.

Virtualization-enabled service management processes and solutions must enable IT to manage the virtualized environment from a service perspective. This presents a particularly vexing problem because the infrastructure services are continually moving across physical resources in the infrastructure. Effective service management in this fluid environment requires answering not only the question, "Where is my server?" but also "Where is my service?" To answer these questions, you must know — at all times and for all services — which virtual resources are delivering which services, and which physical devices are hosting which virtual resources.

This paper:

> Examines the advantages of virtualization and the issues that could inhibit its widespread adoption

> Discusses the implications of virtualization with respect to service management processes and solutions

> Describes the criteria that service management solutions must meet to be truly "virtualization enabled"

Benefits and Challenges

Virtualization is the concept of creating a virtual instance of a physical entity — such as an entire server or PC — and running it on a physical host. It provides two important capabilities.

First, virtualization permits running one or more virtual entities on a single physical host, with each virtual instance appearing to the environment as a separate physical entity. For example, multiple virtual servers can run on the same physical server (see Figure 1). Each virtual server appears as a separate physical server, and the virtual servers can run different operating environments within the same physical host.

Second, virtual "entities," or "guests," can move dynamically across physical hosts. For example, virtual servers can move dynamically across physical host servers.

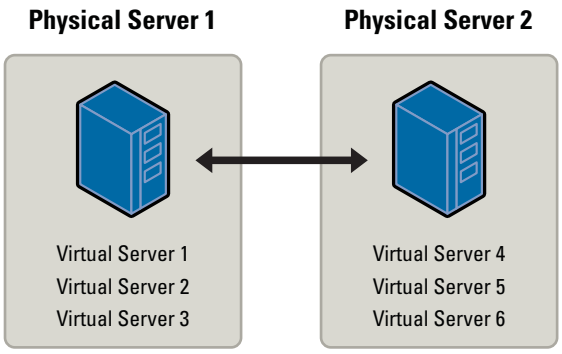

Figure 1. Server virtualization

The combination of these two capabilities creates an enterprise infrastructure that is far more efficient and agile. Server virtualization, for example, reduces server sprawl and optimizes resource utilization. It also enables the enterprise infrastructure to rapidly and dynamically adapt to changes in the environment.

The concepts involved are not new. The concept of running multiple virtual instances of a physical entity on a single physical machine was introduced into mainframe and UNIX® environments decades ago. Multiple virtual instances of a mainframe can run on a single physical mainframe, and multiple virtual instances of a UNIX machine can run on a single physical UNIX server.

There are two major differences, however, between earlier incarnations of virtualization and those emerging in today's distributed computing environment. The earlier virtualization environments are monolithic, with single-vendor hardware, operating system, and system management tools. Compare this to today's distributed environment, which is highly diverse and heterogeneous. Earlier environments are relatively static in that they do not permit the dynamic movement of complete virtual entities across physical hosts. Virtualization in today's distributed environment, on the other hand, does permit this dynamic movement.

There is also an earlier manifestation of the concept of a dynamic computing environment, and that is found in server clustering. Here, two or more physical servers are tightly coupled into a cluster that appears to the outside world as a single, large server (the so-called "single system image"). Clustering has typically been employed for two purposes. First, it has been used for load balancing (where workload is distributed evenly and dynamically across the clustered servers). Second, it has been used to achieve high-availability computing. In this second case, if a primary server in the cluster fails, its workload is automatically transferred to a backup server in the cluster.

There are differences, however, between server clustering and today's concept of dynamic computing through virtualization. Like earlier virtualization implementations, the clustered server environment is monolithic. In addition, clustered servers are tightly coupled, whereas the servers in today's distributed environment are only loosely coupled. The physical servers in a cluster are relatively static. Each server runs an instance of one or more applications or databases and is dedicated to those applications or databases. In other words, it is *workloads* that move across physical servers. In the distributed environment, by contrast, virtual instances of *entire servers* move dynamically across physical servers.

The Virtualization Challenge

If you want to achieve a successful outcome in virtualization and realize its full potential for greater efficiency and agility, you have to carefully plan and configure your migration. In addition, you have to effectively manage, control, and support that environment once you have migrated. If you don't address all three areas — planning, configuration, and management — you will only replace one set of problems with another as you move to the virtualized environment. You may again be faced with server sprawl — only this time, the sprawling servers will be virtual.

Plan

As you expand your implementation of virtualization, it's important to focus on planning. This involves architecting an adaptive infrastructure that can accommodate technology and business change without requiring you to overhaul your technology, processes, and management solutions. Effective planning requires a thorough assessment of current and future capacity requirements to ensure continuing high performance and availability in the face of varying and increasing

workloads. Planning also involves the determination of the optimum mix of virtual servers on physical servers needed to maintain optimum resource utilization, while also delivering required levels of performance and availability.

To plan (as well as configure and manage), you have to know what's out there. That requires the ability to discover all assets, both physical and virtual. To determine optimum virtual-to-physical mixes, an extremely valuable tool is one that permits you to model various combinations of virtual servers on physical servers.

Configure

Once you have planned your architecture, you need to migrate to it smoothly — without disrupting service delivery. Once you have migrated, you need to be able to dynamically reconfigure the infrastructure to meet changing conditions. That requires the ability to automatically and dynamically provision virtual servers to physical servers, while at the same time adhering to corporate policy and regulatory requirements.

You have to control the provisioning of virtual resources just as you do with physical resources. Allow only standard configurations on virtual resources. Move only fully tested and approved ("gold") images to virtual servers. Handle patches and updates to virtual resources with the same level of control as those to physical resources.

Manage

Because of the monolithic, relatively static, and tightly coupled nature of the earlier virtualized and clustered environments, it has been far easier to develop effective service management solutions and tools for them. These tools and solutions have been available for some time. Consequently, many organizations have implemented these earlier manifestations of virtualization and clustered computing in their production environments, while still maintaining effective service management and control.

There is, however, a service management challenge to address before you pursue far-reaching adoption of virtualization. You need to be able to view the IT environment from two perspectives: from the service (end-user) perspective, and from the technology (virtual and physical infrastructure) perspective. These two perspectives permit you to effectively manage performance and availability, and to quickly detect and resolve problems before users are affected. It also helps you to understand the business implications of events within the virtual and physical infrastructure, so you can prioritize action based on business impact.

Enhanced service management solutions enable you to exploit the full potential of virtualization. As these solutions evolve, you can move forward on your initiatives to deploy virtualization technology and realize its full promise.

Evolving from Static to Dynamic Service Management

Effective service management permits you to evolve from managing a relatively static physical environment to managing a highly dynamic virtualized one. The issues of service management in the virtualized environment parallel those in the physical environment in many respects. However, because configurations will change much more rapidly as virtual resources move dynamically across physical resources, virtualization does add a level of complexity. In addition, many of the static connections that exist in the physical environment will "break" in a virtual environment.

When addressing service management in the dynamic virtualized environment, it's also important to consider the impact of service-oriented architecture (SOA). SOA adds another dimension to the challenge of service management. In SOA, by dynamically updating directory and registry entries, a service can "move" dynamically across different resources — both physical and virtual. A Web Services environment, for example, can dynamically change the server that is delivering a particular Web page simply by changing an entry in the Web Service directory. In SOA environments, not only are virtual resources moving across physical resources, but services may also be moving across virtual resources.

An important requirement is that service management solutions enable you to manage the enterprise infrastructure from a business perspective. Business Service Management (BSM) solutions address this requirement by relating technology resources to the services they support. BSM is a comprehensive approach and unified platform for running IT that reduces cost and maximizes business impact. BSM is built on a simple but powerful concept: Since business runs on IT, then IT should be run based on business priorities. The BSM solutions incorporate best-practice IT processes, including guidance from the IT Infrastructure Library® (ITIL®).

Virtualization affects every area of service management, including service automation, service support, and service assurance. As you migrate to the virtualized environment, you must maintain effective, business-centric service management in these three areas.

Service Automation — Maintain Operational Efficiency and Risk Containment

Service automation is responsible for orchestrating end-to-

end IT processes to improve operational efficiency and gain control. This permits IT to achieve superior service quality, security, and business agility, while at the same time reducing risk and costs. Combining service automation with virtualization brings a whole new level of capability, such as paving the way for utility computing. In utility computing, the configuration of the enterprise infrastructure is automatically and dynamically changed to meet changing conditions and workloads.

Every aspect of service automation supports virtualization. This includes:

- **Automated discovery.** Discover both virtual and physical resources.
- **Automated provisioning.** Provision both virtual and physical resources.
- **Automated audit tracking.** Track processes across both virtual and physical resources.
- **Run book automation.** Reevaluate actions taken in response to detected events to accommodate virtual resources. (For example, it may not be appropriate to simply reboot a physical server when an application hangs up in a virtual server running on that physical server. That would unnecessarily take down other properly performing virtual servers running on that same physical host.)
- **Automated configuration and release management.** Treat configuration of virtual resources and distribution of patches and updates with the same level of vigilance and control as you would treat physical resources.

To support virtualization, service automation must also address capacity management, which presents a particularly difficult challenge. For example, in a non-virtualized environment, the resource-consuming entities in a physical host remain relatively static (except in the face of component failures). What varies is the workload on these entities. By tracking and analyzing workload trends, it is possible to determine the capacity required to ensure fast performance.

In a virtualized environment, on the other hand, not only does the workload vary for each virtual entity, but also the virtual entities are moving across different physical hosts. In this dynamic environment, it is far more difficult to determine capacity requirements. Here, you must ensure that the addition of a virtual resource to a physical host doesn't drag down the performance of the other virtual resources running on that same host.

An effective capacity management technique that can be borrowed from mainframe and UNIX virtualization environments is to "cap" (limit) the amount of resources that may be consumed by certain virtual resources. For example, the CPU, memory, and storage resources available to particular virtual servers can be capped. Using this approach, you can allow virtual servers delivering business-critical services to run uncapped, while capping other, less critical, virtual servers. Capping ensures that business-critical services have the resources they need to ensure fast performance.

Service Support — Provide Ongoing Integrity and Support of the Virtualized Infrastructure

Effectively supporting the virtualized environment requires enhancement of change management, incident and problem management, and asset management solutions. With these enhanced solutions, you can take advantage of the efficiency and agility of virtualization, without jeopardizing the integrity of your IT infrastructure or your ability to support it.

Of particular importance is change management. Virtualization introduces a whole new level of agility to the IT infrastructure because it permits changes to be made automatically and exceedingly fast to meet changing conditions. Agility, however, must be carefully balanced with control to minimize the risk of changes disrupting service or violating corporate policy or regulatory mandates.

The best way to ensure that all changes are effectively controlled in both virtual and physical resources is to implement a single, comprehensive change management system (for change request, assessment, planning, tasking, approval, implementation, and tracking) that works across both.

Incident and problem management is another area that must be enhanced. Virtualization adds a level of complexity to incident and problem management because configurations are continually and rapidly changing. For example, the configuration in place at the time a problem occurs may be entirely different than when the problem is reported.

To support virtualization, your incident and problem management solution must provide service desk technicians with information that enables them to associate incidents to both virtual and physical resources. It must also enable technicians to understand the relationships between the virtual and physical resources involved at the exact time the associated incident occurred.

Another important capability of virtualization-enabled incident and problem management is the ability to access information about how physical and virtual IT resources map to the services they support. Resource-to-service

mapping permits IT to prioritize incidents based on their service impact, and hence, their business impact.

Resource-to-service mapping is far more difficult in the dynamic virtualized environment than in a relatively static physical environment because the resources supporting the services may be virtual resources that are moving across physical hosts. Mapping requires continually tracking what virtual server on what physical host is supplying what services.

Finally, virtual resources are assets — just as are physical resources. Consequently, you have to manage virtual assets with the same degree of rigor and control as physical assets. That means enhancing the asset management solution to maintain comprehensive information on virtual assets, as well as on physical assets, such as related support contracts and software licenses, IT support personnel assigned, standard configurations, and usage.

Service Assurance — Deliver Increased Performance and High Availability

With thorough planning, you can minimize the risk of degrading the performance and availability of services and applications when you migrate them to the virtualized environment. Planning alone, however, is not enough. You must also maintain fast performance and high availability of the migrated services and applications once they are released to production. That requires infrastructure management, application management, and service impact management solutions that support virtualization.

With respect to infrastructure and application management, you need to monitor and manage the performance and availability of virtual resources with the same level of vigilance and detail as physical resources. In addition, you need to monitor and manage application stacks that may transcend virtual and physical resources. Finally, you need to monitor performance from the user perspective across both virtual and physical resources. Another important factor in infrastructure and application management is automating the initiation of corrective action to head off problems before performance degrades or failures occur.

Criteria for Virtualization-Enabled Service Management Solutions

To be truly virtualization enabled, service management solutions must meet two major criteria. First, they must be built on a foundation that maintains a comprehensive and accurate view of the enterprise infrastructure in an environment of dynamic and frequent change. Second, the solutions must be capable of not only tolerating, but also taking full advantage of the exciting potential of virtualization.

Foundation Criteria

Virtualization requires an underlying foundation that maintains a holistic view of the enterprise infrastructure, a view that:

- Shows all physical and virtual resources, and their physical and logical interrelationships
- Shows the mapping of virtual resources to their physical hosts
- Shows business services and business processes, and maps them to the underlying IT resources, both virtual and physical, that support them

With these capabilities, you get a complete picture of your IT environment — from business processes and services all the way down to the individual virtual and physical components of the IT infrastructure that support them. This is exactly the kind of data foundation that the configuration management system (CMS) described in the ITIL Version 3 books is intended to provide.

The foundation must be self-updating, so that it automatically detects and records all changes to the enterprise infrastructure — virtual and physical — no matter how frequently the changes are occurring. This includes tracking the movement of virtual resources across physical hosts. The more dynamic the environment, the more critical it becomes to ensure that the changes are accurately reflected in the foundation. If the service management solutions are not all working with the same accurate view of the IT environment, they regress from being part of the solution to being part of the problem.

The foundation must be based on a data model that is future-proof — one that permits the foundation to evolve as the virtualized environment evolves — without overcomplicating the model. Above all, the model should not be constrained by arbitrary limitations on attributes. The "Y2K" scramble, for example, was due to an arbitrary limitation that caused future problems. If 20th-century software developers had established a four-digit rather than a two-digit year field, the Y2K scramble could have been avoided.

Solution Criteria

The right service management solutions not only tolerate virtualization, but also permit IT to exploit virtualization to

its full potential.

The assumptions built into current service management solutions must be reevaluated. Some of these assumptions are based on a relatively static environment. For example, some event management products permit IT to define a set of rules that helps an administrator understand the implications of server events on applications and jobs. The rules, however, may be based on the assumption that the server environment is static; that is, each physical server is dedicated to running certain applications and jobs. As another example, tools that automatically distribute operating system patches to servers may be based on the assumption that each server is dedicated to running a particular operating system. Consequently, these tools tie each server to a specific operating system, such as by relating each machine ID (serial number) to a particular operating system.

These assumptions must be reevaluated in the context of a highly dynamic, virtualized environment. A physical host server can play multiple roles from an operating system, application, and workload perspective, and these roles may change rapidly and frequently. Operating systems and applications bounce around between different physical servers as workloads change. In this highly dynamic environment, rules based on a static environment no longer apply.

Another important criterion is that the solutions not restrict their coverage to a single virtualization technology. Look for solutions that give you the flexibility to employ different virtualization technologies and products, such as VMware, UNIX, IBM®, HP, Citrix, and Microsoft. This permits you to select the optimal mix of technologies for your particular needs.

Conclusion

Virtualization brings a whole new level of efficiency and flexibility to enterprise infrastructures, and it opens up a whole new world of exciting innovations, such as utility computing. However, you need to control the virtualization lifecycle by planning, configuring, and managing the virtualized environment in order to aggressively pursue widespread adoption of virtualization.

Before you can fully virtualize your enterprise infrastructure, you need to ensure that your service management processes and solutions support that infrastructure. That means deploying solutions that enable you not only to tolerate the virtualized environment, but also to exploit it to its full potential. Once you have done that, you can release the brakes on your virtualization initiatives and move aggressively toward full adoption of this exciting technology.

BMC offers virtualization-enabled service management solutions. For more information, visit www.bmc.com/virtualization.

End Notes

1 "Virtual Server Management: A Market Overview of Standards, Products and Providers," Cameron Haight, Gartner Inc., November, 2007

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