WHITE PAPER

Deploying Virtual Infrastructure on Standard Operating Systems

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PREPARED FOR

Microsoft and Novell

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Executive Summary

As it becomes more apparent that virtualization is here to stay, some users may find it intuitively appealing to standardize on a software platform that is optimized solely for virtualization. However, using established operating systems to virtualize workloads offers a variety of benefits related to compatibility, robustness, functionality, security, and manageability issues such as patch management. ESX Server from VMware, SUSE Linux Enterprise Server 10 (SLES 10) from Novell, and Windows Server 2008 from Microsoft are all designed to host virtual infrastructure. However, some key differences in the implementations of these virtualization platforms can have a significant impact on their deployment requirements and manageability.

Xen implementations such as SLES 10, and Microsoft's Hyper-V implementation in Windows Server 2008, fundamentally diverge from VMware's ESX Server in the

IDEAS RECOMMENDATIONS FOR USERS

Ideas International (IDEAS) offers the following recommendations for users who are choosing between the use of standard operating systems such as SLES 10 and Windows Server 2008 to virtualize workloads, versus the dedicated virtualization software approach of VMware:

» Identify dependence on I/O devices, and determine whether drivers for them are supported by VMware's ESX Server.

» Understand the tradeoffs between virtual infrastructure offerings from VMware, Microsoft, and Novell, and determine whether all short-term requirements can be met by the platform being considered.

» Focus on tradeoffs in virtualization management capabilities for these platforms, concentrating particularly on options for provisioning.

» Understand the relationship between managing different levels of the system stack, including software, operating system, virtualization, hardware, and storage. Identify the benefits of having a single management infrastructure for the software/OS and virtualization levels.

» Evaluate the total cost of ownership of a virtualization platform, considering the cost of virtualization software and OS licenses, as well as the impact on tools, support, and processes for management and patching.

The approach used by SLES 10 and Windows Server 2008 – virtualizing I/O through real device drivers in a standard operating system image, rather than in the hypervisor itself – offers significant benefits related to compatibility, robustness, security, integration, and operational consistency.

way that they manage the hypervisor layer, and in the way that they process I/O – two of the operational aspects that are most critical in virtualized infrastructures. The approach used by SLES 10 and Windows Server 2008 – virtualizing I/O through real device drivers in a standard operating system image, rather than in the hypervisor itself – offers significant benefits related to compatibility, robustness, security, integration, and operational consistency. Using standard operating systems to host virtual machines also allows users to take advantage of some rich functionality available in those operating systems – which may include advanced functions for storage management and high availability (HA) clustering.

At minimum, these standard OS attributes will lower the barriers to adopting virtualization in many organizations. Moreover, the benefits of virtualizing on standard operating systems could become increasingly valuable as users become more comfortable with virtual machines and start to drive virtualization technology directly into IT infrastructures.

Virtualization Business Case

Virtualization is clearly having a major impact across the IT industry. Viewed broadly, virtualization involves decoupling workloads and data from the functional details of the physical platforms on which they are hosted. This decoupling increases the flexibility with which the workloads and data can be matched with physical resources, enabling administrators to develop business-driven policies for delivering resources that are appropriate given specific time, cost, and service-level requirements. As a result, virtualization potentially enables IT operations to be performed with far better economies of scale, maximizing the utilization of existing resources by allowing infrastructures to be managed efficiently, even as they undergo high rates of growth.

Operational Benefits of Adopting Virtualization

In the short term, virtualization can solve some specific problems faced by IT managers today. Virtualization has already proven its ability to deliver several fundamental business benefits in a variety of environments, including the following:

» **Consolidation and improved resource utilization.** Depending on the nature of the workloads being consolidated, many organizations routinely achieve consolidation ratios as high as 15-to-1 or more using virtualization. Consolidating servers with virtualization enables administrators to reduce the number of physical machines that they have to acquire and manage, resulting in lower maintenance costs, fewer cooling requirements, less power consumption, and smaller hardware footprints in the datacenter. Virtualization also enables better utilization of computing resources. Because physical servers are often deployed to host single applications, only a fraction of the server's capabilities may be utilized. The remaining resources become "white space" – i.e., unused resources that are rarely, if ever, drawn upon. Virtualization allows multiple underutilized servers to share the resources of a physical system.

When servers are implemented as virtual machines, they can be created almost instantly through either manual commands or scripts. With physical servers, the end-to-end process of installing a new system might take a month or longer . . .

- **Simplified resource provisioning.** Virtualization can significantly reduce the time required to deploy new systems. Rather than set up new physical systems when users require new computing resources, administrators can maintain a pool of virtual resources that they draw upon. When servers are implemented as virtual machines, they can be created almost instantly through either manual commands or scripts. With physical servers, the end-to-end process of installing a new system might take a month or longer, if one includes the time required to spec the needed system; push the request through an organization's requisition process; order the hardware and have it delivered from the vendor; configure the system; and set it up in a server room. With virtualization, that time can be reduced to hours or less. As a result, organizations can respond to business opportunities more rapidly than before.
- **Simplified high availability and disaster recovery.** Virtualization can fundamentally improve the overall reliability of an infrastructure. Virtualization enables fewer physical servers to be deployed, which reduces the footprint for potential hardware failures that result in unplanned downtime. Moreover, the servers that are deployed can be configured with HA features (such as redundancy) and hot-plug components to reduce downtime. The ability to migrate virtual machines from one host to another with minimal interruption to their processing provides yet another means to reduce planned downtime. Such migration allows workloads to be temporarily moved so that hardware maintenance can be performed on the hosts with minimal disruption. When coupled with HA clustering functions, virtualization can be used to restart workloads on a backup host in the wake of a primary host failure – dramatically simplifying the implementation of disaster recovery (DR) procedures. Traditional HA and DR implementation requires applications and their dependencies to be adapted so that they can be restarted on backup systems – which is a notoriously complex and error-prone process. With virtualization, the entire workload can easily be relaunched simply by restarting the virtual machine on which it is hosted.
- **Improved test and development processes.** Virtualization simplifies and improves the quality of testing and development by enabling IT managers to rapidly allocate resources as needed to support test processes. Virtualization makes it easy to set up and manage farms of test systems. Virtualization also helps to isolate bugs during the testing process by neutralizing hardware variability, and it allows production systems to be copied easily for testing purposes. Finally, virtualization makes it easier for developers to test applications on different operating systems.
- **Legacy application support.** Virtualization enables administrators to migrate legacy applications to new hardware without disturbing their environment. In some migration situations, it may be difficult or impossible to move certain applications to the new platform. In the case of third-party software, the application vendor may no longer be in business; in the case of an internally developed application, the source code may have been lost or the original developers may have moved on. In these circumstances, virtualization can be used to extend the life of the application. The legacy application can be hosted

Microsoft's Hyper-V virtualization platform, which will be integrated into its forthcoming Windows Server 2008 operating system, has an implementation very similar to Xen's, and will offer compatibility with Xen implementations such as the one in SLES 10.

in a virtual machine running on the new platform until that application can be replaced or rewritten.

Virtualizing Single Servers vs. Virtual Infrastructure

As users become more comfortable with virtualization, they start to look beyond the application of virtualization on single servers and drive virtualization technology more directly into IT infrastructures – extending the scope of its functionality from single servers to multiple systems throughout a datacenter or organization. As virtualization technology becomes a standard function in various platforms, users will increasingly be able to assume that at least some virtualization capabilities will be available on all of their systems. When basic virtualization functions are coupled with higher-level management tools that are specifically enabled to manage multiple virtual systems, they can become the foundation for entire virtualized infrastructures. In virtualized infrastructures, multiple virtualized systems are treated as a flexible pool of resources that can be allocated dynamically in response to changing workload conditions or downtime events. The goal of deploying such virtualized infrastructures is to move beyond merely lowering acquisition costs by targeting issues that can be the source of significant operational costs.

Because virtualization isolates workloads from the details about the servers on which they are hosted, it becomes possible to move a workload from one machine to another without disturbing its application environment. For example, some virtual machine implementations enable the entire state of a running virtual machine to be captured in a standard file, so that it can be transported across a network. Workloads can be migrated from one physical server to another simply by copying this file across the network. Applications running in the virtual machine continue to operate in the exact same environment (including operating system and middleware) without any knowledge of the actual physical location.

The ability to transfer virtualized workloads across the network in this manner enables a number of operations that can greatly affect operational costs, including:

» **Managing planned and unplanned downtime.** Administrators can upgrade hardware or swap a new server in place of an old one without reinstalling the operating system or application software. When coupled with HA clustering functions, this capability can also be used to restart workloads on a backup host in the event of a primary host failure.

» **Maintaining service levels**. The ability to migrate virtual machines across a network simply by copying files also simplifies the implementation of server load balancing, whereby workloads are migrated from heavily loaded servers to less busy machines.

Deploying virtualization can help increase system availability in a variety of ways. First, the savings in server acquisition costs resulting from consolidation free up capital that can be invested in tools for implementing automated HA and DR. Further, consolidating multiple servers into virtual machines on fewer physical

Xen implementations such as SLES 10, and Microsoft's Hyper-V implementation, fundamentally diverge from VMware's ESX Server in the way that they manage the hypervisor layer, and in the way that they process I/O – two of the operational aspects that are most critical in virtualized infrastructures.

systems decreases the overall hardware footprint, and thus reduces the number of potential sources of downtime that can result from hardware failure.

Fewer servers resulting from consolidation also simplifies infrastructure, making it easier to mirror for recovery purposes. Because virtual machines have no awareness of the physical hardware on which they are hosted, administrators have the flexibility to configure backup infrastructure with a different class of hardware than the primary platform; hence, less expensive hardware can be used in standby systems that are normally idle.[1] Although the performance of these systems will be lower when they take over production workloads, customers typically accept reduced performance for a limited period of time in the wake of a failure.

Perhaps a different approach to reducing the cost of providing backup capacity is to use test/development systems for backup. These systems can be preconfigured with a virtual image that remains "idle" until it is needed to recover the failing production workload. Resources can then be dynamically "stolen" from the development or test virtual systems and added to the production system when they are needed.

Virtualization is increasingly becoming a standard part of IT infrastructures, both in hardware and software. Almost every major operating system now includes some support for virtualization, and new options for virtual machine platforms are still being announced. Ultimately, virtualization could redefine how datacenters are configured and maintained. However, the process of deploying virtual infrastructure begins with selecting a virtual machine platform for the initial applications, and some important tradeoffs should be considered as part of this process.

Positioning Virtual Machine Architectures

IBM is recognized for developing virtualization capabilities on its mainframe servers long ago. More recently, VMware introduced virtual machine software for the x86 platform. VMware first began shipping its enterprise server product, ESX Server, in 2001. Since then, a number of alternatives to VMware have appeared on the market. One of the first virtual machine server platforms to gain significant traction in the market after VMware was Microsoft Virtual Server, which began shipping in 2004. Then, the Xen virtual machine hypervisor appeared, which is based on open source software. The Xen hypervisor has been integrated into several leading Linux distributions, the first of which was Novell's SUSE Linux Enterprise Server 10 (SLES 10), which introduced Xen-based virtualization functions in 2006. Microsoft's Hyper-V virtualization platform, which will be integrated into its forthcoming Windows Server 2008 operating system, has an implementation very similar to Xen's, and will offer compatibility with Xen implementations such as the one in SLES 10.

[1] Note that some commonality between host hardware is required for migration to occur. For example, if a virtual machine platform is using virtualization hardware such as Intel VT, then the backup server must also be configured with Intel VT.

Operating systems running in virtual machines can access devices using standard device drivers (i.e., the exact same drivers used when the administrative operating system is running directly on hardware).

VMware, SLES 10, and Windows Server 2008 are all designed for server virtualization. However, there are some key differences in the implementation of these platforms that can have a significant impact on their deployment requirements and manageability. To understand these tradeoffs, it is necessary to take a closer look at how virtual machine platforms are organized.

Basic Technical Challenges of Virtualization

One of the basic enablers of virtualization is the ability to run multiple operating systems simultaneously on a single server. The most flexible way to accomplish this task is to use virtual machines, which create an entire computer system in software that can be operated and controlled as if it were an application. Implementing a virtual machine platform has several specific functional requirements, including the following:

- **Scheduler.** This component doles out access to physical resources by different virtual machines. The scheduler uses a time-slicing mechanism with a policy based on weights and reserves that administrators set up for the virtual machines
- **Memory management.** This component allocates and de-allocates virtual memory to the different virtual machines on a server.
- **State machine.** This component maintains information about the running state of a virtual machine, including its CPU, its memory, its devices etc.
- **Storage and networking.** This function enables shared access to storage and networking resources by multiple virtual machines. To accomplish this feat, the component has to somehow multiplex (i.e., time-slice) access to the real devices (i.e., the host bus adapters [HBAs] or network cards) from the virtual machines. This multiplexing has to occur in a way that is consistent (i.e., data is read and written correctly regardless of the pattern in which virtual machines execute), isolated (i.e., no software failure during I/O in one virtual machine can cause instability in any other virtual machine), and secure (i.e., no virtual machine can have visibility of the I/O occurring in any other virtual machine).
- **Virtualized devices**. This function is the bridge between the virtual world and the physical world. It provides operating systems running in virtual machines with representations of devices that behave the same as their real world counterparts, so that devices can be accessed by applications as if the applications ran on physical servers (i.e., through device driver software [see below]).
- **Virtual device drivers.** These components are installed in “guest” operating systems running inside virtual machines so that applications can access the virtual representations of hardware and I/O connections the same way that they access physical hardware and I/O connections on real machines.
- **Binary translation.** This function was required in the earliest generations of virtual machine implementations for the x86 architecture, which was not designed for virtualization and therefore somewhat inhospitable to the functionality that virtual machines require. Traditionally, virtual machine

. . . when virtualization functions are hosted on standard operating systems, they can take advantage of proactive functions to maintain secure infrastructure, such as directory services for performing authorization and authentication.

platforms performed a translation or emulation procedure every time a guest operating system attempted to execute a "privileged" instruction (i.e., a low-level instruction that, in order to maintain consistency, only the host OS has the right to perform). More recently, Intel and AMD introduced hardware in their processors to assist virtualization. These assists enable multiple virtual machines to issue privileged instructions that can be detected and processed directly in hardware. As a result, it is no longer necessary for virtual machine platforms to perform this function in software.

» **Management interface.** A virtual machine platform has to provide a variety of interfaces for managing its operation, and for controlling the virtual machines running on a host. This interface has to cover a multitude of operations, such as creating virtual machines, configuring them, monitoring their execution, etc. Moreover, it is necessary to provide both interactive interfaces (i.e., those used by administrators) and programmatic interfaces (i.e., those used by other software through an Application Programming Interface [API]). Further, in today's IT environment, it is essential for the management interface to be fully accessible over the network so that the virtual machine host and its virtual machines can be configured and operated remotely.

OS-Based Virtualization vs. Special-Purpose Virtualization Software

All virtual machine platforms must implement the above components and functions in some form or another. In practice, though, virtual machine platforms can differ greatly in the way that they implement these functions and tie them together. The core functions of a virtual machine platform are the scheduler, memory management, and state machine components (i.e., the components for allocating the most basic computational resources such as CPU and memory to the virtual machines). In newer virtual machine platforms, such as Xen and Microsoft's Hyper-V, these functions are collectively called a "hypervisor." The hypervisor is also responsible for creating partitions and maintaining strong isolation between partitions. VMware's high-end virtual machine platform implements these functions in a software package called ESX Server, which it now also describes as being based on a hypervisor-like mechanism. Indeed, Hyper-V, Xen, and ESX Server are not that different in terms of the way that they fundamentally control virtual machines.[2]

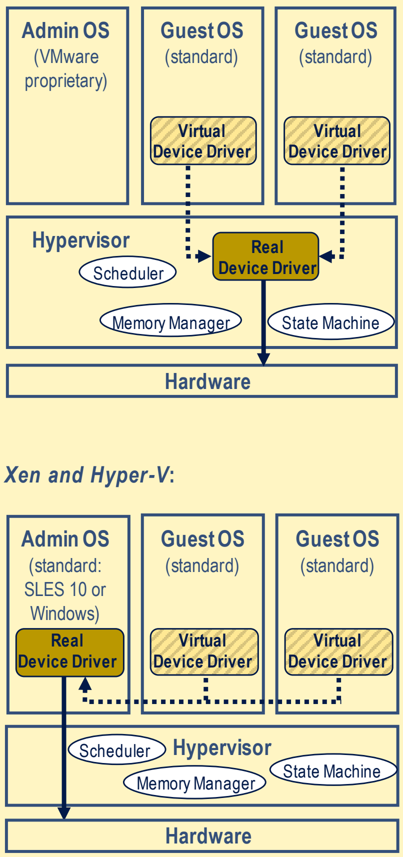
However, Xen implementations such as SLES 10, and Microsoft's Hyper-V implementation, fundamentally diverge from VMware's ESX Server in the way that they manage the hypervisor layer, and in the way that they process I/O – two of the operational aspects that are most critical in virtualized infrastructures. All three of these approaches involve the installation of virtual device drivers in the guest operating systems, which communicate with real device drivers to perform the

[2] One key difference is in the area of binary translation. ESX Server still relies on binary translation to process privileged instructions, as do some Xen implementations. However, Microsoft's Hyper-V relies entirely on virtualization hardware in Intel and AMD processors to detect and process privileged instructions.

FIGURE 1

Administration and Device Drivers in VMware vs. Xen and Hyper-V

VMware ESX Server:



actual I/O. However, in VMware's ESX Server, the real device drivers reside in the hypervisor layer itself. With Xen and Hyper-V, the real device drivers reside in a special administrative virtual machine, which runs a standard operating system such as SLES 10 or Windows Server 2008. Using a high-performance channel, the virtual device drivers in guest operating systems communicate with standard device drivers in the administrative OS, which perform I/O directly on hardware (see Figure 1). As a result, the administrative OS performs all of the storage and networking functions, while in VMware, these functions are performed in the hypervisor layer.

While the difference in these approaches may appear to be subtle, it can have a major impact on the way that the virtual machine platforms are deployed and managed. Virtualizing I/O through real device drivers in standard operating systems can provide the following benefits:

» **Compatibility.** Operating systems running in virtual machines can access devices using standard device drivers (i.e., the exact same drivers used when the administrative operating system is running directly on hardware). For example, if the administrative operating system is running a Linux distribution such as SLES 10, guest operating systems have access to any device drivers supported by SLES 10. Similarly, if the administrative operating system is running Windows Server 2008, guest operating systems have access to any hardware supported by that version of Windows. By contrast, VMware requires users to acquire device drivers that are specifically created for ESX Server. While the ESX Server device driver model is similar to that of Linux, developers nonetheless have to create VMware-specific versions of their code – which means that they have one more platform to test and support. Driver developers typically focus on Windows and/or Linux first, before they address other platforms such as ESX server. Hence, VMware users may not immediately be able to obtain virtualized access to the newest hardware.

» **Robustness and security.** By shifting the burden of managing the device drivers, as well as the network and storage functions, to the administrative operating system, the hypervisor itself becomes simpler and requires less code (for this reason, the designs of hypervisors like Xen and Microsoft's Hyper-V are typically referred to as "thin"). Fewer lines of code can improve the robustness of the hypervisor layer, simply because there are fewer opportunities for failure. Less code can also improve security, because it reduces the "attack surface" through which intrusions can occur. The security of the hypervisor is also improved by the lack of storage and networking functions, through which a variety of breaches can occur. Finally, when virtualization functions are hosted on standard operating systems, they can take advantage of proactive functions to maintain secure infrastructure, such as directory services for performing authorization and authentication.

» **Integration with existing infrastructure.** The use of standard device drivers, and traditional networking and storage functions, by the virtual machine host makes it straightforward to integrate virtual machines with existing systems. Support for standard device drivers allows virtual machines to access whatever

When the administrative OS is a standard environment such as Windows or Linux, users can apply their existing system management tools and procedures to the virtual machine hosts.

hardware is already in place. The continued use of standard storage and networking functions means that users can deploy the exact same extensions for both virtual and physical infrastructure.

- **Operational consistency.** When the administrative OS is a standard environment such as Windows or Linux, users can apply their existing system management tools and procedures to the virtual machine hosts. This consistency applies to both interactive tools (such as consoles and GUIs) and programmatic interfaces (i.e., the APIs used by add-on applications). Implementing virtualization within the OS also improves integration with existing infrastructure by leveraging existing tools and processes for patching, providing support, etc.

These benefits apply in the general case when virtual machines are hosted on standard operating systems. Further, depending on the capabilities of the operating system used to host virtual machines, the approach can yield other benefits as well, resulting from the functional strengths in the host OS. In this regard, it is worth examining some key properties of SLES 10 and Windows Server 2008, and how they might benefit the deployment of virtualization.

Achieving Virtualization Benefits with SLES 10 and Windows Server 2008

Both Microsoft and Novell are adding virtualization capabilities to the newest releases of their server operating systems. Novell has been shipping an implementation of the Xen hypervisor in SUSE Linux Enterprise Server 10 since July 2006. Microsoft is building support for virtualization into its next-generation Windows Server 2008 operating system, which will be introduced in February 2008 (the Hyper-V function itself will begin shipping within 180 days of the Release to Manufacturing [RTM] of Windows Server 2008).

Both Microsoft and Novell are employing standard administrative operating systems for their virtual machine platforms (i.e., Windows Server 2008 in the case of Microsoft, and SLES 10 in the case of Novell). Moreover, Microsoft and Novell have developed joint support capabilities to provide compatibility across their virtual machine platforms. The technical collaboration agreement between Microsoft and Novell has resulted in technology that allows customers to host virtual machines running SUSE Linux Enterprise on top of Windows Server 2008, or virtual machines running Windows Server 2008 on top of SUSE Linux Enterprise.

Both companies will continue to focus on optimizing their respective platforms for homogeneous virtualization (i.e., SUSE Linux Enterprise virtual machines hosted by SLES 10, and Windows virtual machines hosted by the Windows Server 2008). Further, Microsoft and Novell are each adding value on top of their respective virtual machine platforms for managing virtualized workloads and implementing virtual infrastructure. Wherever possible, these offerings take advantage of the inherent compatibility between their standard operating systems and virtual machine functions.

Microsoft and Novell have developed joint support capabilities to provide compatibility across their virtual machine platforms by taking advantage of the similarity between Hyper-V and Xen.

Basic Virtualization Scenarios

Both Novell and Microsoft tout the use of their respective virtual machine platforms for the key virtualization use cases, including consolidation, testing and development, business continuity, and support of legacy applications. SLES 10 and Windows Server 2008 serve as optimal hosts for consolidation, in part due to their strong 64-bit capabilities. 64-bit support is useful when users want to deploy large numbers of virtual machines on a single physical server, which is typical for consolidation. In this case, the increased memory capacity of a fully 64-bit-enabled system provides more headroom for stacking up consolidated systems. Microsoft also provides a particularly robust set of software development tools that work well together with its virtual machine platform, helping large-scale development teams take advantage of virtualization in order to shorten development times. Finally, both Microsoft's and Novell's virtual machine platforms support older versions of Windows and SUSE Linux Enterprise as guest operating systems, allowing users to continue running legacy workloads that depend on these systems.

Manageability

With virtualization increasingly becoming a standard part of hardware and operating system software, much of the interest around virtualization across the industry is shifting to its impact on management tools and processes. Ideas International (IDEAS) has found that virtualization does not fundamentally change the way that users perform systems management overall. In general, administrators continue to use the same management tools on virtual servers that they use on physical servers. Both Microsoft and Novell are investing extensively in enhancing their management capabilities, and these investments will apply directly to virtual infrastructure hosted on their respective operating systems.

In addition to addressing bi-lateral virtualization, the technical collaboration agreement between Microsoft and Novell includes collaboration on key systems management standards as well as directory and identity interoperability, both of which will be critical in helping customers deploy virtual infrastructures spanning the Windows and SUSE Linux platforms. At its Brainshare conference earlier this year, Novell showed that it had already done quite a bit of work bridging the systems management tools and procedures in Linux and Windows. So far, it has publicly demonstrated interoperability between Novell and Microsoft software at multiple levels, including:

» Accessing Microsoft's Sharepoint Server with Novell eDirectory identities via Federated Services

» Managing Domain Services for Windows (a Linux-based implementation of Microsoft's network directory services) running on SLES from a standard Microsoft Management Console (MMC) interface running on Windows

» Establishing a trust relationship between Microsoft's Active Directory and Domain Services for Windows

In addition to addressing bi-lateral virtualization, the technical collaboration agreement between Micro-soft and Novell includes collaboration on key sys-tems management stan-dards as well as directory and identity interoperability, both of which will be critical in helping customers dep-loy virtual infrastructures spanning the Windows and SUSE Linux platforms.

- » Creating cross-forest trust between standard instances of Windows Server 2003 and SLES
- » Adding users to Active Directory from Novell's iManage administrator interface

Both Microsoft and Novell have another advantage in managing virtual infrastructure: the ability for their management tools to couple the instrumentation of their respective virtual machine platforms with the instrumentation of their operating systems. The ability for administrators to gain end-to-end visibility over the state of software in their system stack can be invaluable in maintaining the performance and availability of virtual infrastructure. This comprehensive view enables a degree of insight that is not possible in other virtual machine management solutions from "pure-play" virtualization providers such as VMware, or from hardware vendors with an interest in virtualization, such as Dell, HP, and IBM.

Provisioning Tools

Because it is so much easier to configure new virtual machines than physical machines, end users often respond by increasing their demand for new systems. As a result, with the adoption of virtualization, administrators are under greater pressure to provision the growing number of virtual servers with the necessary software to support workloads (i.e., operating systems, patches, middleware, application software, etc.). The key to meeting this challenge is to apply sophisticated provisioning tools, which can help to ease the burden of installing and maintaining the software necessary to productively run workloads in virtual machines.

Novell offers an option called ZENworks Orchestrator, which is optimized for automating resource provisioning to meet the needs of changing workloads on SUSE Linux Enterprise (and other platforms). ZENworks Orchestrator works well to provision Xen virtual machines on SLES 10, thanks in part to the fact that the Xen administrative OS can be treated no differently than other SLES 10 environments from a management standpoint. Microsoft offers an option for deploying software called System Center Configuration Manager 2007, the successor to the System Management Server (SMS) software distribution system, which is one of its most mature systems management products. Together with other products in Microsoft's growing portfolio of System Center management products, including System Center Virtual Machine Manager, tools such as System Center Configuration Manager will allow Windows administrators to directly extend their expertise at maintaining physical systems to virtual infrastructure hosted on Windows Server 2008.

Microsoft recently extended its System Center management architecture with a new component called Virtual Machine Manager (VMM), which allows virtualized systems to be managed with the same interface that System Center provides for managing physical systems. The support for virtualization in System Center means that other tools in the family – i.e. System Center Configuration Manager 2007 – can be used to automate the process of installing software in virtual machines. System Center Configuration Manager 2007 uses a model-based approach to

In the design of their solutions, Novell and Microsoft are taking advantage of several factors in their favor, including the ability to directly integrate virtualization with other critical operating system functions, and the introduction of virtualization hardware in the newest x86 processors.

define a desired state of the environment, and makes sure the environment stays in that state by applying any necessary patches and software updates. One of the key features in System Center VMM is a self-service web portal through which authorized users can provision new virtual machines themselves (i.e., without directly involving IT staff). This capability is especially useful in test and development scenarios, in which developers need to frequently set up virtual machines on a temporary basis.

The IDEAS Bottom Line

Users agree that the benefits of virtualization are well worth its adoption, which helps to explain the tremendous interest that has developed around virtualization platforms. But for many users, the key question is how to introduce virtualization in a way that is the least disruptive. Indeed, the choice of which virtual machine platform to adopt is becoming an increasingly strategic decision, with far-reaching consequences. The approaches of hosting virtual machines on dedicated virtualization software such as VMware and hosting them on standard operating systems such as Linux and Windows each have their own set of tradeoffs. While it may seem intuitively appealing to introduce a software platform that is optimized solely for virtualization, in fact, using established operating systems to virtualize workloads offers a variety of significant benefits related to compatibility, robustness, functionality, and the ability to integrate with existing infrastructure, support processes, and patching mechanisms.

With the ability to support existing device drivers, standard operating systems do not require developers to adopt a new device driver model. There are literally tens of thousands of drivers in existence for the x86 platform today, and the last thing developers and users want to hear is that they need to rearchitect their drivers, negotiate with their hardware OEM, or contact their ISV to obtain new drivers. Virtual machines running on SLES 10 and Windows Server 2008 will benefit from the exact same drivers that users have known for years. Also, from an architectural standpoint, placing these drivers into an administrator operating system, rather than the hypervisor itself, can potentially improve the reliability and security of the host platform.

Further, when virtual machine functions become integrated into standard operating systems, users no longer have to acquire a separate virtual machine solution, with its associated support contracts and training requirements. They can manage the virtual machine hosts with their existing interfaces in the exact same way that they managed physical systems before, even as these tools are extended to gain insight over the virtualization functions in the OS. They can also maintain the same tools and procedures for maintaining and patching the virtual machine host environment, while leveraging the existing security infrastructure to perform authentication and authorization. Finally, the use of standard operating systems for hosting virtual machines allows users to take advantage of the rich functionality that is available in those operating systems, which may include advanced functions for storage management and HA clustering.

The architecture of VMware's platform stems from historical circumstances. When VMware started to develop its platform in the 1990s, it worked within constraints that were quite different from those of today. At that time, the x86 architecture was suboptimal for hosting virtual machines, and required VMware to focus on solving problems such as binary translation. Further, as an independent software developer, VMware did not have the ability to integrate its virtual I/O capabilities directly into a leading operating system. In the design of their solutions, Novell and Microsoft are taking advantage of several factors in their favor, including the ability to directly integrate virtualization with other critical operating system functions, and the introduction of virtualization hardware in the newest x86 processors. As a result, they can offer virtual machine platforms that have lower barriers for adoption within existing physical infrastructures, even as they provide a solid foundation for deploying new virtual infrastructures.

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