Technical White Paper
DATA CENTER

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SUSE® Linux Enterprise Server 10

Virtualization with Xen and Use Cases

Novell®

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Overview

Novell is committed to the propagation of Xen virtualization technologies. These technologies are included in the release of SUSE Linux Enterprise Server 10, the latest open source server operating system from Novell.

Resource utilization. Efficiency. Scalability. Availability. Manageability. Security. These are the issues that keep data center managers awake late into the night. Virtualization technologies can address these concerns and benefit the entire enterprise, but they haven't been widely adopted—that is, until recently.

What's changed? Well, for starters, the data center. The number of physical servers has grown to unmanageable proportions. Enterprises need virtualization technologies to compensate for the inefficiencies of increasing server sprawl. Linux* has taken a more prominent role in enterprises[1]—handling everything from edge services (Web, firewall, DNS and DHCP) to middle-tier application and middleware; from backend database, e-mail and file serving to commercial high-performance cluster computing and enterprise grid deployments. More and more enterprises are also turning to Linux to help address their multi-tier server consolidation issues. In addition, Intel and AMD have designed virtualization functionality into the latest x86 and x86-64 processors—adding hardware support for server consolidation by enabling strict fault and performance isolation. They've also added functionality that enables unmodified operating systems to run concurrently on the same physical machine.

In this rapidly changing landscape, Linux vendors such as Novell have recognized the possibilities for data center transformation. These organizations are now releasing a new generation of products designed to integrate virtual machines—increasing efficiency and managing resources in ways that were unforeseen just a few years ago.

Novell is committed to the propagation of Xen* virtualization technologies. These technologies are included in the release of SUSE® Linux Enterprise Server 10, the latest open source server operating system from Novell®. This unique opportunity for Novell to take a leading role in the shift to virtualization-based IT is due to the convergence of commodity hardware and open source software—that is, Linux running on x86 and x86-64 computers. It's a combination that is transforming racks of compute and storage servers into the preeminent enterprise IT platform. Virtualization is also differentiating applications as they evolve into self-contained modular services. Xen virtual machines take that evolution one giant step further.

SUSE Linux Enterprise Server 10 and Xen virtualization technology—coupled with open-standards-based management solutions and identity-driven, directory-based technologies—enable your data center managers to treat all the hardware and software in the data center as a pool of interchangeable resource components. In effect, the technology now exists to dynamically bring together what you need, when you need it, and in ways that make sense for your business.

Lose Servers, Gain the Upper Hand

There's a reason why the typical data center contains a sea of servers, each running a single application: isolation minimizes the impact of crashes. A buggy application running on its own server can only bring itself down. A bad fan, a disk failure, or an I/O problem will only affect the one application that's dependent on the defective hardware. Besides, single applications running on ever-more powerful hardware leave nothing to chance regarding headroom. The set-up may be inefficient, but it works.

1 *"Linux Adoption and Server Consolidation: Linked Opportunities for Infrastructure Rationalization," Robert Frances Group, February 20, 2004.*

So, if you decide to use virtualization technologies to consolidate resources and improve resource utilization, they must provide the same level of application-workload isolation, fault isolation and tolerance, and headroom as the current data center configuration. In other words, if you have several virtual machines (VMs) running on a single physical machine, the performance of one application (or lack thereof) must not affect the others, and administrators must know that they won't come up short with regard to CPU cycles, memory, I/O bandwidth or other necessary system resources. SUSE Linux Enterprise Server delivers high-availability components that help ensure service level availability—even when virtualized—thus satisfying the requirements of the modern data center environment.

SUSE Linux Enterprise Server 10 running on Xen delivers VM isolation for both software faults and varying workloads. By combining this VM isolation in a failover cluster that integrates commodity hardware, enterprises can achieve a high level of fault tolerance for hardware failures as well. Furthermore, working hand-in-hand with other software from Novell and partners, full-scale integration of virtualization technologies is possible—across physical and virtual servers, SANs and I/O—allowing resources to be pooled, allocated and utilized like never before.

Virtualization Primer

Virtualization refers to the pooling of IT resources in a way that masks the physical nature and boundaries of those resources from resource users. In more concrete terms, virtualization is the decoupling of software from hardware. It is the abstracting of the software from the underlying implementation. (For a more detailed overview, please read the Novell white paper "Virtualization in the Data Center," located at: www.novell.com/collateral/4622015/4622015.pdf)

With regard to Xen, there are two primary virtualization models:

- **Full Virtualization.** *In this type of virtualization, a full platform is emulated by means of hardware or software—or a combination of both—in order to support an unmodified operating system. With this method, there's no need to customize the guest operating system. However, since the operating system was designed to run on physical hardware, it's not aware of the Virtual Machine Monitor—also known as the "hypervisor." As a result, the VM can't cooperate with other VMs to share resources and optimize performance.*
- **Paravirtualization.** *Unlike full virtualization, paravirtualization only partially emulates hardware. The hypervisor is supplemented by APIs that assist in abstracting the underlying hardware resources to the virtual machine. Paravirtualization requires hardware-dependent portions of the guest operating system to be modified to become aware of the virtualization layer. Currently, depending on the specific usage case, paravirtualized VMs can outperform fully virtualized VMs.*

One of the benefits of Xen 3.0, as included in SUSE Linux Enterprise Server 10, is support for both paravirtualized and fully virtualized VMs when the physical server is based on the latest x86-based processors from Intel* (Intel VT) or AMD* (AMD-V). These processors feature in-silicon virtualization technology that works with Xen 3.0, giving you a choice of virtualization models to meet your specific needs.

SUSE Linux Enterprise Server 10 running on Xen delivers VM isolation for both software faults and varying workloads.

With the release of SUSE Linux Enterprise Server 10, Novell stakes its claim as the first enterprise Linux distribution vendor to integrate Xen into the operating system.

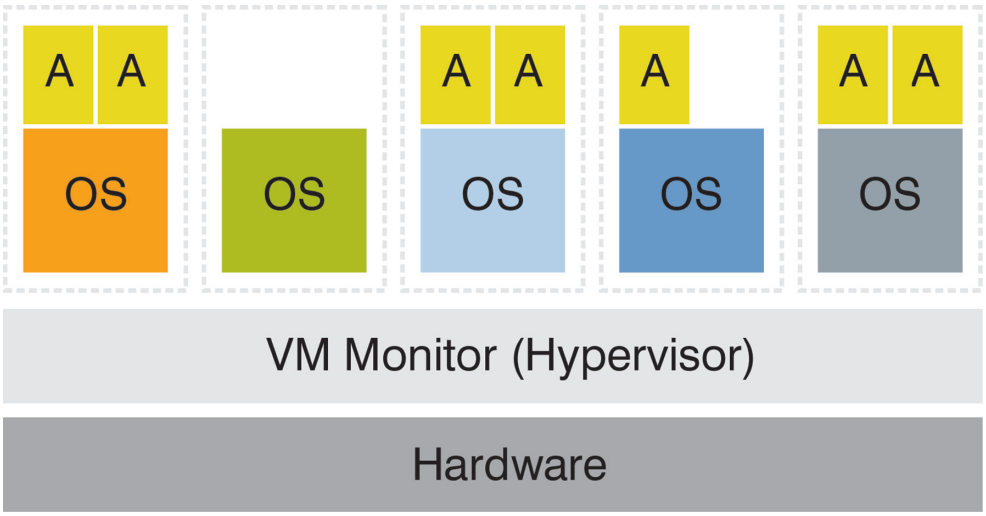

Figure 1. *Hypervisor-based virtualization: Virtual machines are enabled by a Virtual Machine Monitor (hypervisor) layer that sits between the OS and hardware. This layer mediates access to hardware resources and permits multiple OS instances to coexist on a single server.*

Xen Rises to the Occasion

Xen 3.0 is a virtual machine monitor (VMM) or hypervisor. It is a software foundation that governs operating systems' access to computer resources, such as memory and network adapters, in order to securely execute multiple VMs—each running its own operating system on a single physical system.

Developed by engineers at the University of Cambridge as an open source project, Xen is the industry's fastest and most secure server virtualization software technology. It has been endorsed and adopted by more than 20 of the industry's major vendors, including AMD, Dell, Hewlett-Packard, IBM, Intel, Novell, Red Hat and Sun Microsystems. Because Xen technology is open source, it has continued to attract more and more contributors—essentially becoming an open standard. As a result, many companies are now building commercial toolsets for Xen virtual machine management.

Novell contributes four times more code to the Xen project than any other Linux vendor. And now, with the release of SUSE Linux Enterprise Server 10, Novell stakes its claim as the first enterprise Linux distribution vendor to integrate Xen into the operating system.

With the Xen code and management tools that ship as part of SUSE Linux Enterprise Server 10, you can run multiple operating systems on the same physical server with minimal performance impact. As a result, you can significantly increase server utilization, reduce server sprawl and lower costs. SUSE Linux Enterprise Server 10 and the Xen 3.0 virtualization engine afford impressive new levels of resource utilization and improvements in availability, manageability, scalability, performance, application security and much more.

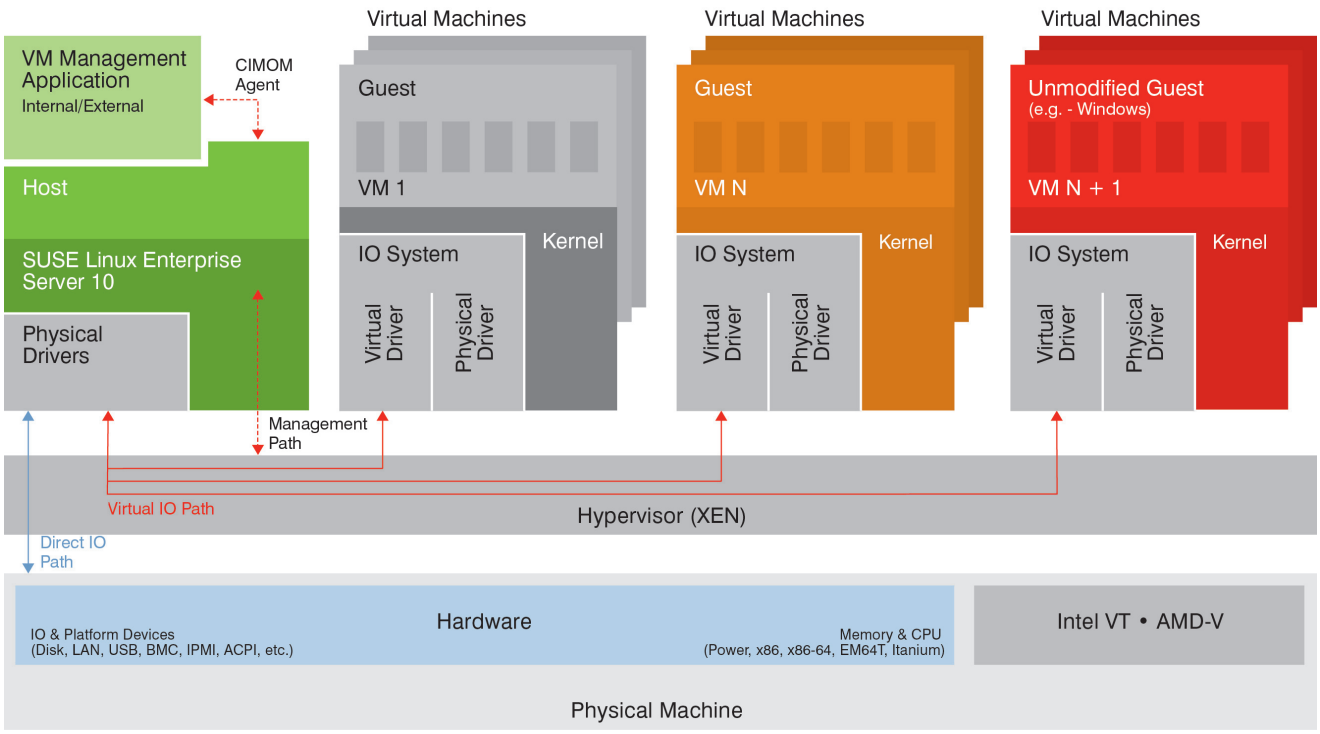

Figure 2. *Basic enterprise architecture featuring Xen virtualization with paravirtualized guest operating systems. These are running on an unmodified operating system assisted by the latest x86 server chip that includes virtualization technology.*

Xen currently runs on x86 and x86-64 systems. Ports are currently underway to IA-64 and PPC. Ports for other platforms are also technically possible and may be available in the future.

Deployment and Management of Virtual Machines

The Xen hypervisor and related tools enable control of the resource abstraction layer, virtual machine lifecycle management and physical resource reallocation. In effect, Xen is a base technology that can distribute and control the available physical resources of a system.

SUSE Linux Enterprise Server 10 simplifies virtualization technology management with YaST, a comprehensive installation, configuration and administration suite that is integrated into the SUSE Linux Enterprise platform. YaST gives IT administrators a common foundation for managing operating system components as well as accompanying services and third-party applications. YaST is ideal for creating virtual machine profiles and configuring individual VMs because it takes you through the same series of screens that you use to provision a physical machine. Novell ZENworks® Linux Management complements YaST by enabling IT administrators to centrally control how they deploy and update systems—or virtual machines—inside the firewall. By using YaST and ZENworks Linux Management, administrators can easily install, configure, update, secure and manage SUSE Linux Enterprise Server 10 and the virtual machines it hosts. Administrators can also start up, shut down or suspend virtual machine operating system instances and migrate VMs from one physical server to another in order to relocate a load or prepare for maintenance.

Novell ZENworks Linux Management complements YaST by enabling IT administrators to centrally control how they deploy and update systems—or virtual machines—inside the firewall.

SUSE Linux Enterprise Server 10 includes the YaST installation and system management tool, which lets you build VMs, copy them as files and distribute them using ZENworks Linux Management. Novell and industry partners provide the tools to monitor and manage virtual machines efficiently.

Novell engineers are currently working on higher-order management tools, including centralized mechanisms to oversee Windows*, Linux and UNIX* systems. The goal is to schedule prioritized virtual machine-based workload units intelligently and automatically across available pooled physical resources. SUSE Linux Enterprise Server 10 is the foundation for this vision.

Use Cases for Xen Virtualization Technology

Let's take a look at some of the ways Xen virtualization technology can be used to lower costs, increase flexibility, simplify management and ensure reliable operations. We'll look at several methods for using Xen in the areas of server consolidation, on-demand computing, highly available computing and managed-resource quality of service (QoS).

Server Consolidation

Case 1: Reining in Server Sprawl

A typical enterprise has multiple servers, all running single applications and averaging only five to 40 percent[2] CPU utilization. Servers are cheap but not that cheap. Machines or blades take up valuable real estate, and they drive electricity costs higher with their power and cooling requirements. And, depending on the size of the organization, a large IT staff might be the only way to manage all those servers successfully. If this sounds familiar, you know that the status quo is ridiculously inefficient. And now, you need more computing power but can't stand the thought of adding even more servers.

- **The Solution**—*SUSE Linux Enterprise Server 10 and Xen virtualization software enable several virtual machines to run on a single server. Each VM contains an instance of the operating system and an application. This configuration harnesses previously unused compute power and brings CPU utilization up to 80 percent or more.*

  The enterprise can obtain two to eight times more real work per server as a result of virtualization. The server installed base can be reduced by retiring old servers, and administrators can put their skills to work on something more productive than managing server sprawl. In addition, the company can achieve significant savings through lower power consumption and recouped floor space—and can use that money to fund key business processes instead.

- **Necessary Components**
  – *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*

- **Essential Notes**—*Take care that you don't replace server sprawl with virtual machine sprawl. SUSE Linux Enterprise Server 10 includes the YaST installation and system management tool, which lets you build VMs, copy them as files and distribute them using ZENworks Linux Management. Novell and industry partners provide the tools to monitor and manage virtual machines efficiently.*

2 *"Server Virtualization: Taking Charge of Your Servers," Bittman/Gartner Group, December 2005.*

Case 2: Bringing Flexibility to Resource Utilization

Most enterprises are extremely inefficient when it comes to using CPU resources, memory and peripheral channel capacity (LAN or disk). Servers, as previously mentioned, usually operate at around five to 40 percent[3] of CPU capacity. Disk space and bandwidth are often shared, but allocation is generally haphazard and rarely tied to business policies.

As a result, IT managers often have to double as referees—monitoring and controlling the flow of data through the enterprise's IT infrastructure while manually ensuring that disparate systems and services work well together. But even so, a buggy or inefficient second-tier application can slow the whole operation down.

- **The Solution**—*With SUSE Linux Enterprise Server 10 and the Xen hypervisor, you can dedicate resources dynamically and react quickly to changing business demand. You can treat your entire server installed base as one interchangeable pool. This gives you flexibility; you can conveniently manage all your resources, assigning workloads as business needs emerge. You benefit from a streamlined environment and a downsized installed base of physical servers that you can optimize to handle changing workflow conditions. To get the best performance from these servers, you can use open source workflow-management tools that analyze the status of production work and drive workload processing according to business policies.*

  Your IT managers can support a multiple-end-user environment, enabling distributed processing and control for better overall performance, system utilization and QoS. In fact, your managers can tune systems to adjust for QoS parameters, to abide by service level agreements (SLAs) or for other purposes. For example, VM1, which contains a Web server, can be allocated more disk I/O bandwidth during the day, compared to nights when there is less Internet traffic and when payroll and other back-end applications are running in other VMs.

  In addition, SUSE Linux Enterprise Server 10 and Xen keep applications isolated in their own virtual machines so they cannot negatively affect other applications' performance. And SUSE Linux Enterprise Server 10 protects application integrity because Xen-based VMs confine the application, libraries, services and operating system into workload-specific containers. This is the next level of isolation and protection beyond what an application security framework (such as Novell AppArmor™) typically provides. Moreover, Xen virtualization helps you protect your infrastructure against single points of failure by running more than one instance of an OS and application within separate VMs anywhere in your organization.

  SUSE Linux Enterprise Server 10 features a cluster file system you can use to manage VM images as files and run them on any server connected to the file system. You can automate storage provisioning and shared-disk authorization to compute servers that host virtual machines. By combining virtual machines and virtualized storage, you can easily deploy applications into dedicated virtual servers that are scheduled across available compute and storage hardware.

- **Necessary Components**
  - *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*
  - *System management suites that support open standards*

- **Essential Notes**—*SUSE Linux Enterprise Server 10 gives you the first glimpse of this remarkable technology. In future releases, the OS and more sophisticated management tools will help you achieve even higher levels of automated server-workload resource utilization management.*

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3 *"Server Virtualization: Taking Charge of Your Servers," Bittman/Gartner Group, December 2005.*

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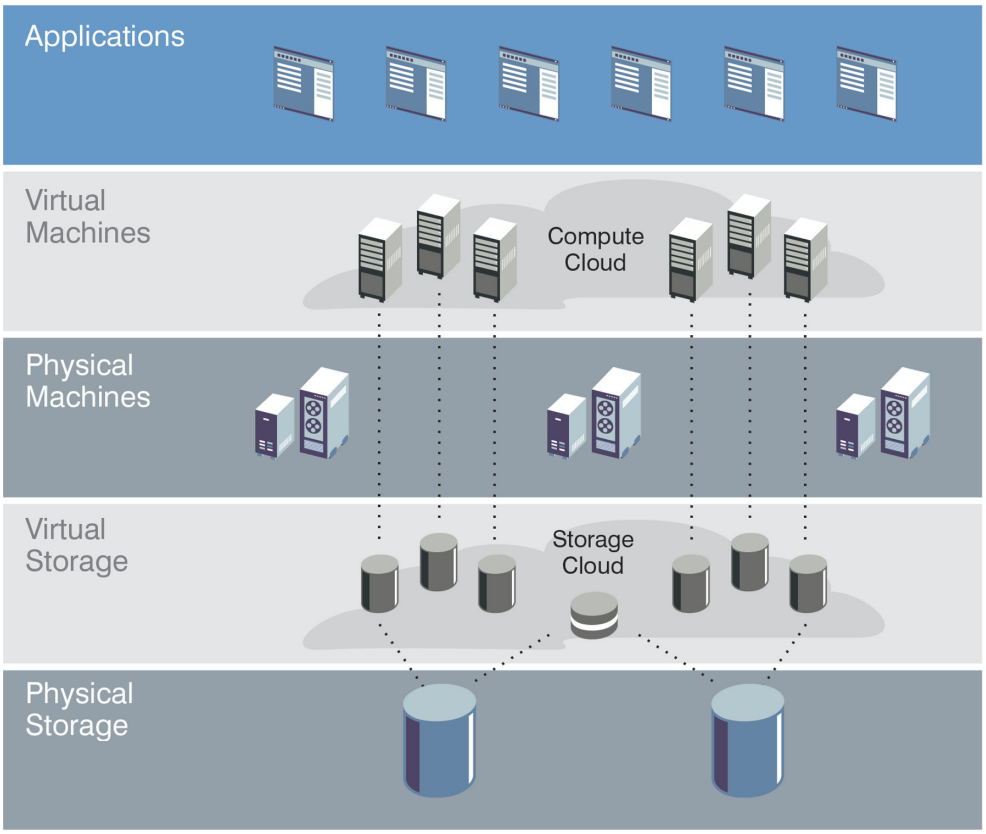

Figure 3. *SUSE Linux Enterprise Server 10 features a cluster file system that, in combination with Xen virtual machines and open source management tools, can take virtual machine images and run them on any server connected to the file system. By combining virtual machines with virtualized storage, you can easily deploy applications into dedicated virtual servers that are scheduled across available compute and storage hardware.*

On-demand Computing

Case 3: Efficiently Managing Unpredictable Workloads with Dynamic Resource Allocation and/or VM Server Migration

Here again, the one-application/one-physical-server model is to blame for extreme inefficiency. Compute resources are static and dedicated to (as well as restricted by) hardware. For example, even when an application isn't running and isn't scheduled to run for days or weeks, the application is welded to the physical server, whose resources won't be used for any other purpose. In the meantime, peak demand might exceed another physical server's capacity, but idle resources on one server cannot be used to assist another.

- **The Solution**—*A key benefit of virtualization is that it allows you to expand and shrink resources dynamically—adding memory, CPU bandwidth and network bandwidth as needed (up to the physical limits of the server). With this flexibility, you can support a spike in an application's workload without physically and permanently dedicating resources to the application.*

  Another technique that works well for handling workload spikes—such as Web servers that experience cyclical swings in usage—is to add more VMs as needed on existing hardware to take full advantage of available processing power. When peak demand subsides, you can shut down these additional VMs and allocate computing resources to other activities in the network.

  A third technique is to use Xen to migrate a VM from one physical server to a larger one, without interrupting service. This is especially useful if your data center is creating a utility or "on-demand" computing model, or if your hosting site must allocate or guarantee levels of service based on CPU bandwidth, network bandwidth or I/O bandwidth metrics. Easy migration of VMs allows hosting centers to efficiently manage their available resources based on different clients and their QoS requirements. Easy migration is also extremely useful when you are implementing rolling upgrades or making general resource adjustments. And it is ideal for high availability and disaster recovery. A VM can be relocated to an alternative location such as a remote data center with near drag-and-drop simplicity.

- **Necessary Components**
  - *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*
  - *Novell ZENworks Linux Management*
  - *A cluster file system (e.g., Oracle* Cluster Filesystem 2/OCFS2, shipped with SUSE Linux Enterprise Server 10), enabling the VM to see its virtual disk no matter where it's running*

- **Essential Notes**—*VM migration is not yet sufficiently tested nor completely supported in SUSE Linux Enterprise 10 at the time of general availability. This functionality will be available in Service Pack 1.*

  Live migration is a planned activity and cannot accommodate unpredictability and unforeseen failures.

Easy migration of VMs allows hosting centers to efficiently manage their available resources based on different clients and their QoS requirements. Easy migration is also extremely useful when you are implementing rolling upgrades or making general resource adjustments.

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Highly-available Computing

Case 4: Clustering to Optimize Operations

Traditional high-availability architectures involve interruption and loss of the application's non-persistent state, since the application or service must be restarted after migration to another node in the cluster. This leads to inevitable service interruptions, however brief. Also, in many enterprises, this requires IT staff to perform hardware maintenance outside of production hours.

- **The Solution**—*SUSE Linux Enterprise Server 10 and Xen technology allow failover of a virtual machine from one physical machine to another in a cluster without interrupting the VM's operations. The VM maintains the complete OS and application states throughout migration. When coupled with a cluster parallel file system such as OCFSv2* and a high-availability resource manager such as Heartbeat 2, live applications can be moved in a cluster among physical machines without interruption. Xen avoids an application restart by moving the actual running machine. As a result, hardware maintenance can be performed on live applications during production hours without any interruptions.*
- **Necessary Components**
  - *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*
  - *Novell ZENworks Linux Management*
  - *OCFS2 (shipped with SUSE Linux Enterprise Server 10) or another cluster parallel file system*
  - *Heartbeat v2 (shipped with SUSE Linux Enterprise Server 10) or another HA resource manager*
  - *EVMS2 Enterprise Volume Manager (shipped with SUSE Linux Enterprise Server 10)*
- **Essential Notes**—*VM migration is not yet sufficiently tested nor completely supported in SUSE Linux Enterprise 10 at the time of general availability. This functionality will be available in Service Pack 1.*

  Live migration is a planned activity and cannot accommodate unpredictability and unforeseen failures.

Case 5: Fast Disaster Recovery

Suppose that you want to deploy a new application stack. You're storing it in a centralized virtual machine image file server and plan to deploy it from there to the target server. Before deployment, you protect your application- and user-specific data with the snapshot functions available in EVMS2—or those included with your SAN storage hardware. During deployment of the new application stack, however, a server failure occurs. The new application is not deployed or secured, and it remains unavailable to end users.

- **The Solution**—*With Xen 3.0, recovery is quick and easy. You simply copy the application stack from the central virtual machine image file server, recover application-specific data snapshots and get right back to production.*
- **Necessary Components**
  - *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*
  - *Novell ZENworks Linux Management*
  - *EVMS2 Enterprise Volume Manager or third-party Storage Area Network (SAN) snapshot tools*
  - *File server dedicated to centralized virtual machine image management*
- **Essential Notes**—*This scenario presumes the integration of various components and available automation tools.*

Managed Quality of Service

Case 6: Creating Test Environments that Can Be Moved Easily into Production

Your enterprise has developed a new solution stack, and you are using a test system to evaluate performance characteristics in various usage scenarios. An important part of this testing is to assess resource utilization so you can determine the resources required on target machines for optimum performance. It can be a difficult process, however, as testing the stack on different machines with different configurations is extremely expensive and time-consuming.

- **The Solution**—*With Xen 3.0, you can perform resource evaluation in a very flexible virtualized environment, using just one virtual machine. Once the solution has been tested and optimized, you can centrally deploy and manage the application stack image on available target machines.*
- **Necessary Components**
  - *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*
  - *Novell ZENworks Linux Management*
  - *File server dedicated to centralized virtual machine image management*
  - *Accessible shared network storage that satisfies application stack requirements for persistent data management.*

An important part of testing is to assess resource utilization so you can determine the resources required on target machines for optimum performance. It can be a difficult process, however, as testing the stack on different machines with different configurations is extremely expensive and time-consuming.

Virtualization cuts an entire dimension from your testing matrix, as the Xen 3.0 hypervisor is rigorously tested and Novell YES certified to ensure reliability.

Case 7: Simplified Certification Due to Hardware Abstraction

In heterogeneous environments, the testing and certification matrix is very complex. Typically, any group of servers contains a variety of different network and disk adapters. Different vendors use different adapters, and even within a single vendor's line of servers, you will often find different revisions of the same basic adapter. Now, multiply this by the number of operating system types that exist in your network—and the various versions of each—as well as the many applications that run on them. Any IT manager who must deal with this type of environment knows that certifying the entire software stack against the hardware is a formidable task.

- **The Solution**—*Virtualization introduces a layer of separation between the operating system and hardware. Each operating system, therefore, needs only a simple, generic driver that talks to Xen for each type of hardware—disks, network adapters and so on. This driver is independent of the specific brand of hardware, since Xen—working together with SUSE Linux Enterprise Server 10—handles all communication with the hardware. As a result, the virtual platform (hardware, SUSE Linux Enterprise Server 10 and Xen) can be certified separately from the software stack (operating system and application). Virtualization cuts an entire dimension from your testing matrix, as the Xen 3.0 hypervisor is rigorously tested and Novell YES certified to ensure reliability.*
- **Necessary Components**
  – *SUSE Linux Enterprise Server 10 with Xen 3.0 installed*

Key Virtualization Benefits

Server Consolidation

- *Use up to 80 percent of server capacity (instead of the five to 40 percent utilization typical of most servers).*
- *Reduce the number of servers required and gain square footage for other purposes.*
- *Minimize overall hardware costs.*
- *Reduce costs through reduced cooling requirements, lower power bills and decreased management.*

Dynamic Provisioning

- *Dynamically grow or shrink resources without physically dedicating them to a particular application.*
- *Avoid paying for extra hardware just to meet temporary peak demands.*

Virtual Hosting

- *Efficiently leverage available hardware resources and provision them in a dynamic, controlled manner.*
- *Take advantage of automation and fine-grained control of resources to lower the cost of service offerings, as well as your administrative and hardware costs.*

Reliability, Availability and Security

- *Support automated application failover solutions that do not interrupt service to production environments.*
- *Isolate applications in containers that minimize vulnerabilities and provide outstanding protection against hacking.*
- *Protect applications from unproven or defective applications by isolating application libraries, services and operating systems.*

Dynamic Scalability

- *Add more processing power by automatically deploying VM images on existing hardware to handle the temporary increase in demand.*
- *Shut down additional VMs when peak demand subsides, reallocating resources to other activities on the network.*

Improved Workload Management

- *Decouple applications from the underlying hardware in order to allocate resources—CPU cycles, memory, bandwidth—according to dynamically changing needs.*
- *Run multiple operating systems on a single server to increase productivity and enable more in-depth development and testing.*
- *Free up servers for additional projects.*

High Availability and Non-Stop Maintenance

- *Migrate a virtual machine—while it's running—from one physical server to another without interruption.*
- *Perform maintenance in a production environment during regular business hours with zero downtime.*

Streamlined, Enhanced Test/Deploy Cycles

- *Minimize the need to handle different, physical machines when testing interdependent applications, operating systems and physical servers.*
- *Use VMs to contain and control unstable or test configurations, avoiding disruption to other services.*

Greater Operational Agility

- *Drastically reduce server-provisioning time.*
- *Allocate resources according to business needs.*
- *Free IT staff to work on a more productive, efficient and agile data center.*

Novell Is Putting It All Together

"Our strategy is to build a Linux plus Novell and open source-based platform that offers differentiable value through sophisticated integration of otherwise isolated components… Consider the evolution of computing from mainframe to mini to client/server. Now modularize, standardize, commoditize and virtualize. Next add integrated intelligence, and you have a modern "computer" comprising virtualized compute and storage that is controlled by a distributed operating system..." —"Virtualization, Utility Computing and Grid," Novell, Inc., Wipfel et al.

Virtualization changes everything. Your traditional notions about installing or patching a server, for example, are radically challenged by the realization that the physical server merely represents anonymous hardware on which virtual machines can run. You can perform installations and apply patches to offline operating systems completely distinct from any particular hardware you might eventually choose to run your virtual machine.

Xen virtualization technology and the clustering capabilities integrated into SUSE Linux Enterprise Server 10 provide the foundation for some remarkable developments in the data center. Developments that can take place now.

Today's SANs and intelligent storage servers make it possible to dynamically provision and re-provision network storage. Standards such as CIM-based SMI-S permit software, rather than humans, to provision, assign and manage network storage. So, opportunities now exist to automate storage provisioning and shared-disk authorization to compute servers hosting virtual machines. By combining virtual machines with virtualized storage, you can feasibly deploy applications into dedicated virtual servers that are scheduled across compute and storage hardware based on availability of resources.

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When you unite virtual machines, virtual storage, resource management and identity management, you get a comprehensive and dynamic data center management solution.

Nearly all the pieces are in place. With Xen virtualization technology incorporated intoSUSE Linux Enterprise Server 10 and the Novell commitment to standards—in particular CIM-based, data center-class management tools—it's only a matter of time before Novell and partners deliver an adaptive, policy-based, identity-driven compute environment that is entirely responsive to business needs.

Contact a sales representative for more information, or visit www.novell.com/datacenter to learn more about Novell Data Center solutions.

Contact your local Novell Solutions Provider, or call Novell at:

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