Best Practice Guide

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OES 2: Virtualization & Consolidation

prepared for

Novell OES 2 Linux Customers

Published: October, 2007

Novell

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Virtualization Best Practices

Virtualization, first introduced in the 1960s to allow partitioning of mainframe hardware, is now becoming a mainstay of commodity hardware systems and high-end proprietary server environments. Virtualization software allows a single piece of hardware to concurrently run multiple operating system images and has the potential to improve resource utilization, efficiency, scalability, and manageability.

In most cases, the newer hardware being used in today's data center is considerably more powerful than that used previously. In addition, OES 2 Linux is equipped to take full advantage of these powerful servers. Given this situation, it is reasonable to expect to consolidate the services of multiple existing NetWare platforms onto a smaller number of physical OES 2 Linux servers. This document discusses some of the options for using virtualization to take advantage of this opportunity.

This document is one of a series of three that discuss best practices for migrating from NetWare to OES 2 Linux. See also:

- Migrating from NetWare to OES 2 Linux Best Practice Guide
- OES 2 Linux Migration Utilities Best Practice Guide

These additional documents can be accessed from the NetWare to Linux Migration Sources on the Novell Open Enterprise Server Migration Web site.

Why Consider Virtualization?

When SUSE Linux Enterprise Server 10 was released, it included the ability to run multiple self-contained virtual machines on a single physical server using Xen-based virtualization. This implementation provided out-of-the-box support for fully virtualized and paravirtualized Linux guest operating systems.

Novell Open Enterprise Server 2 adds the ability to run NetWare 6.5 as a virtualized guest operating system. You can also mix and match, hosting a SUSE Linux Enterprise server and a few NetWare servers, or vice versa on the same physical machine. In most cases, services run in a virtualized environment just as they do on a physical server and require no special configuration or other changes. You may, however, need to assign additional memory to the virtual machine depending on the load.

If you are not familiar with the virtualization features of OES 2, we recommend the following resources as a starting point:

- **Novell Connections Magazine.** This magazine has run a series of articles, written by Ken Baker, over the last several months that introduce new OES 2 features; some of these are devoted wholly to virtualization; others contain sections explaining the advanages of virtualization and how virtualization works on OES 2. We recommend them as a quick read and an excellent source for information. See the following:
  - Sneak Peek
  - Migrating from NetWare to OES
  - Finalizing the Transition to Linux -The Wait Is Over
  - Managing NetWare on a Virtualized Machine
- **Novell Product Documentation**. The product documentation is, of course, the primary source for information. See the following:

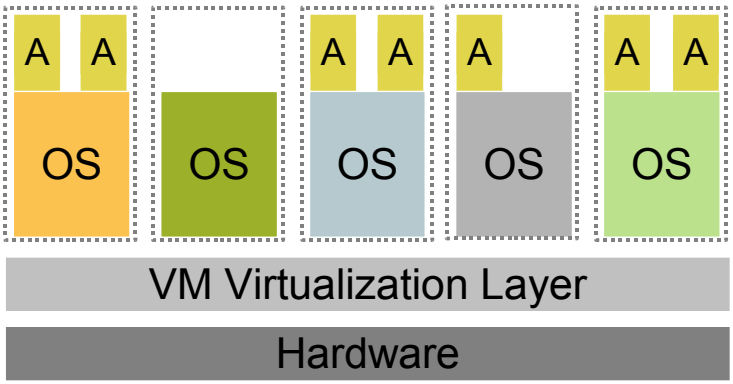
- **Installing Hosts.** For complete information about installing a virtual machine host and setting up virtual machines in general, see Virtualization: Getting Started, particularly section 3.0, "OES 2 Linux Virtual Machines."
- **Installing Quest Operating Systems**. For complete information about installing NetWare 6.5 SP7 and OES 2 Linux as guest operating systems, see Section 2, "NetWare Virtual Machines" and Section 3, "OES Linux Virtual Machines," in the Virtualization: Guest Operating System Guide.
- **Running OES 2 Services on Virtual Machines**. For information about installing and running OES 2 services on virtual machines, see the links in the Virtualization page of the OES 2 Online Documentation.

There are several reasons for considering virtualization, the following among them:

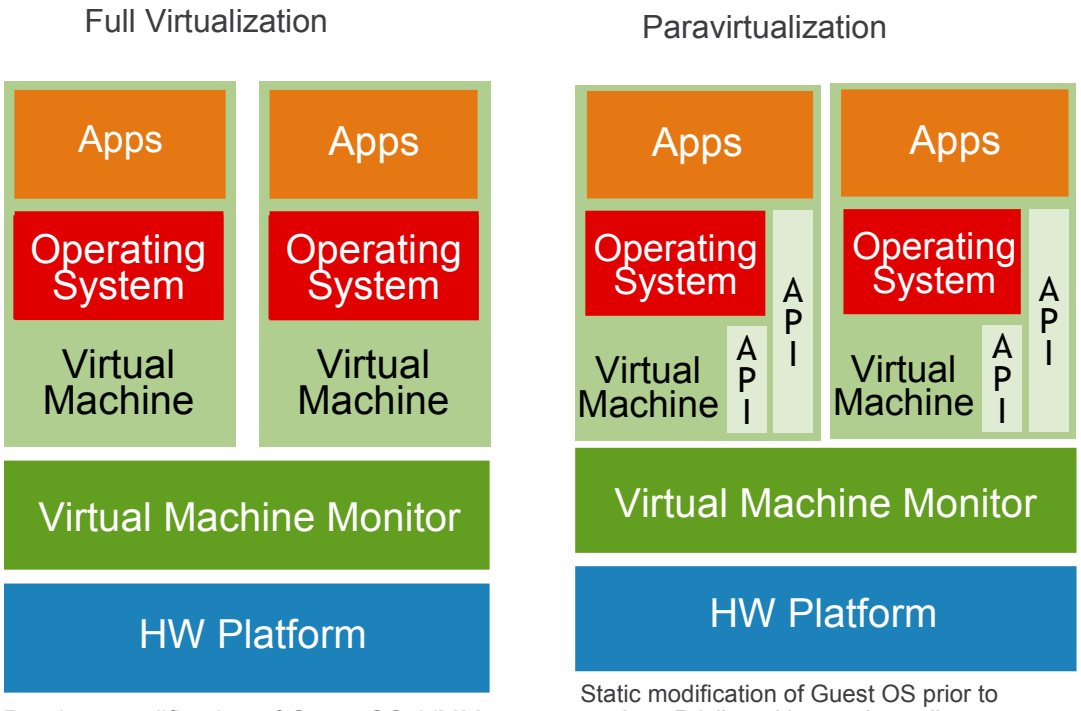
- As noted above, the processing power of servers has increased dramatically. In the past, most companies ran individual applications on a dedicated server, but many applications simply don't require anywhere near the computing capacity that newer server microprocessors now provide (some estimates indicate that fully 60% of computing power is unused). With virtualization, you can reduce the number of servers by running multiple applications on a single server. In addition, you can provision applications dynamically—moving virtual machines (VMs) from one server to another (and one customer to another) as needed. One-application/one-server configurations make less sense with every passing year.
- Modular deployments that feature multiple-server, high-availability clustering and failover solutions as well as Web services are much more predominant in today's computing environments. In these complex environments where scalability is essential, the capacity of an application shouldn't be capped by the servers on which it is running. With virtualization for example, if you have an eight-node cluster, you might want to consider running three or four of those nodes as virtual cluster nodes. This can reduce power and physical space requirements while still providing high availability for cluster services
- Leading x86-chip manufacturers have released a new generation of chips that integrate virtualization technologies into x86 architectures. These chips support virtualization natively and make software virtualization products more efficient, robust, secure, and flexible; they also allow you to create partitioned application spaces running on a single operating system.
- Virtualization can also contribute to disaster recovery strategies; you can create and store virtual machine images of any supported operating system. If the physical host machine experiences a problem, these virtual machine images can quickly be loaded onto another physical host.

Virtualization works in the following way as the graphic below indicates:

- It's enabled by a layer that sits between the OS and the hardware.
- OS instances think they are controlling the "real" machine.
- The virtualization layer
  - Mediates access to hardware resources
  - Permits multiple OS instances to coexist in single server
  - Allows even incompatible OS's to share a server



Guest operating systems are hosted on virtual machines in either full virtualization mode (sometimes referred to as hardware virtualization mode (HVM)) or paravirtual mode. Each has advantages and disadvantages.



- **Full virtualization mode.** This mode lets virtual machines run unmodified operating systems (hosts unmodified guest OS binaries). VMware* servers are the most popular, full virtualization-based virtual machines.

  This mode traps and emulates all privileged instructions on the guest OS, but performance is negatively impacted, sometimes by as much as 50%. In addition, some processors (x86 architectures, for example) are difficult to fully virtualize.

In addition, full virtualization doesn’t allow cooperative resource sharing when two VMs are run on the same box at the same time. Licensing complexity and scalability limitations are also persistent concerns.

- **Paravirtual mode.** With this mode, the base Linux kernel is modified to handle calls from other domains on the physical server. It differs from full virtualization in that para-(or partially) virtualized operating system instances are modified to become aware of the virtualization layer. This helps the hypervisor avoid hard-to-virtualize processor instructions by replacing them with a procedure call that provides that functionality. It also allows for cooperative memory-sharing between machines.

  This mode does not require the host computer to support hardware-assisted virtualization but does require its operating system to be modified for the virtualization environment.

  Typically, operating systems running in paravirtual mode enjoy better performance than those using full virtualization mode.

  SUSE Linux Enterprise Server 10 and NetWare® 6.5 SP7 are paravirtualized operating systems. Leading vendors offering paravirtualization *management* solutions include Virtual Iron and XenSource. Both vendors are Novell partners.

Many vendors, in addition to Novell, offer virtualization components that are either fully virtualized or paravirtualized as well as robust management utilities. You'll want to evaluate products for "best fit" in your environment. Refer to Virtualization Software Vendors on page 11 for example vendors and a comparison matrix.

Xen or VMware?

Both Xen and VMware are good choices for virtualization products, and OES 2 supports both. Each has its advantages (and disadvantages) and each has a different set of requirements. You'll want to evaluate these requirements to see how they might affect your migration plans and your overall network infrastructure. Brief discussions of both follow.

VMware Virtualization Environment

VMware, one of the early leaders in the Virtualization market, is the most widely deployed, fully virtualized software suite for optimizing and managing industry-standard IT environments through virtualization (VMware is owned by EMC, Inc., a Novell partner).

VMware includes a full set of management capabilities with its ESX platform and offers easy provisioning and multi-processor support. Primary limitations include potential performance degradation due to code scanning to ensure that no “privileged” operations are being run by the Guest OS. It is limited to x86 and x86_64 processors.

VMware Infrastructure 3 is the next generation of infrastructure virtualization software. This product virtualizes servers, storage, and networking, allowing multiple unmodified operating systems (including Windows) and their applications to run independently in virtual machines while sharing physical resources. The suite delivers comprehensive virtualization, management, resource optimization, application availability, and operational automation capabilities.

VMware Infrastructure is available in three editions: Starter, Standard, and Enterprise. The VirtualCenter Management Server is sold separately. The following products are also available as separately licensed products:

- VMware VMotion
- VMware HA
- VMware DRS

See the VMware Web site to access a product brochure, discussion forums, technical papers, and webcasts. You can also obtain an evaluation copy and learn more about virtualization benefits and suite features. See http://www.vmware.com/products/vi/

Xen Virtualization Environment

Xen 3.0 is an open-source virtual machine monitor (VMM) or hypervisor developed by the University of Cambridge (UK) as a research project. It governs operating systems' access to computer resources, such as memory and network adapters, in order to securely run multiple VMs—each running its own operating system—on a single physical system. This allows multiple operating systems to talk to the hardware as if each were the only one on the server. Where necessary, XEN also allows a guest OS to own a physical device exclusively. Xen is licensed under the General Public License (GPL) and is available for free download.

Because Xen enables guest operating to be tuned and optimized for virtual machines, administrators can securely run several virtual machines on a single physical system with performance comparable to native code. There are no additional subscription fees for guest images.

One of the benefits of Xen is that it's included with Novell Open Enterprise Server 2 as part of SUSE Linux Enterprise Server 10. Whether you're running Linux or NetWare virtual machines, it can detect that they're virtual servers and then load them in paravirtualized mode to take full advantage of the AMD V and Intel VT chips for increased performance.

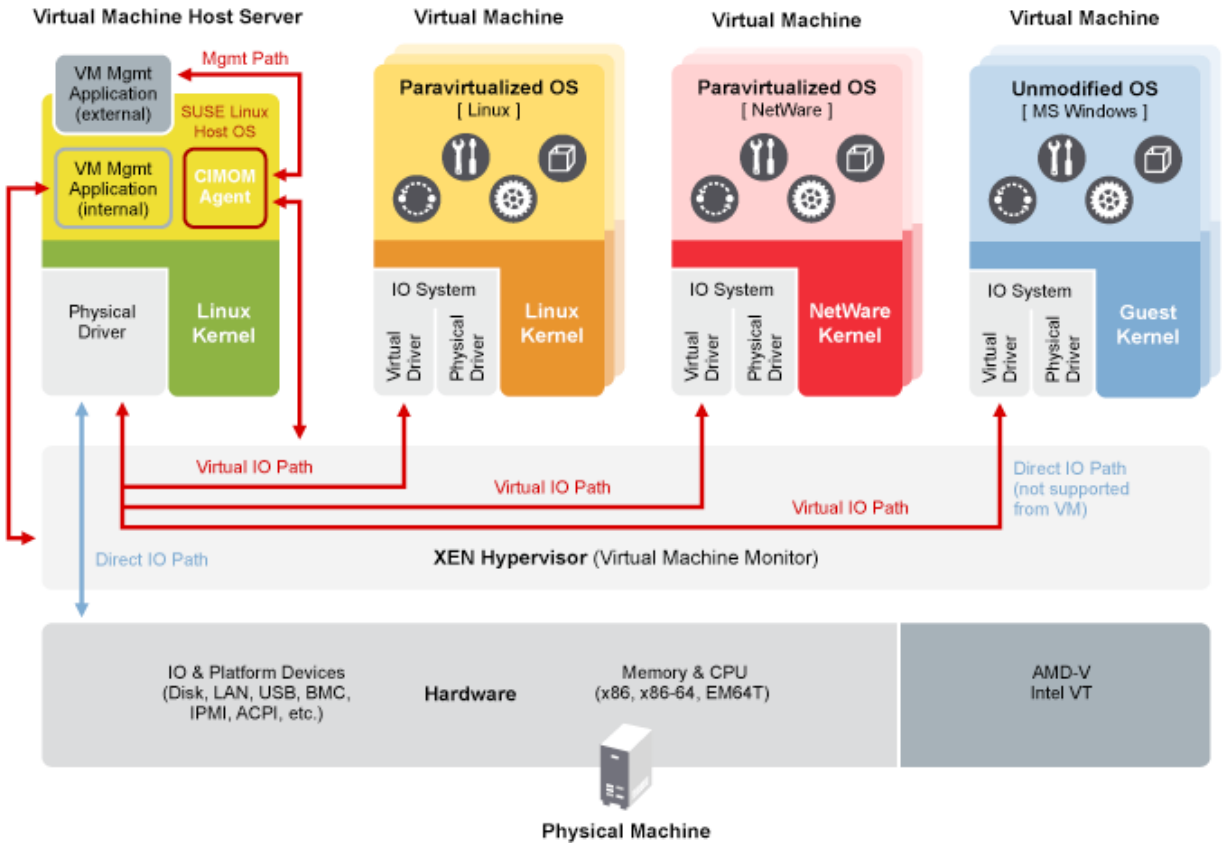
Xen-Based Components

The basic components of a Xen-based virtualization environment are listed below. Collectively, they form a platform for hosting virtual machines. The physical computer running all these components is referred to as the virtualization host server.

- The **Xen hypervisor** (or virtual machine monitor) is an open-source software program that coordinates the low-level interaction between virtual machines and physical hardware.
- The **management virtual machine** (also referred to as domain 0) is comprised of several components:
    - The SUSE Linux operating system, which provides a graphical desktop and command line environment to manage the virtualization host server components and its virtual machines
    - The xend daemon, which stores configuration information about each virtual machine and controls how virtual machines are created and managed.
    - A modified version of QEMU, an open-source software program that emulates a full computer system, including a processor and various peripherals. It provides the ability to host operating systems in full virtualization mode.
- Any number of other **Xen-based virtual machines** (also referred to as domains), consisting of the following components:
    - At least one virtual disk that contains a bootable operating system
    - Virtual machine configuration information, which is managed by the xend daemon and can be modified via a text file
- The tools, commands, and configuration files that let you manage and customize the virtualization environment.

The following graphic illustrates a typical Xen Virtual Machine architecture.

Xen Virtual Machine Architecture



SUSE Linux Enterprise Server 10 , SP1 (which is included with OES 2):

- Fully supports Xen 3.0 virtualization on both 32- and 64-bit x86-based architectures
- Offers support for paravirtualization through the Xen hypervisor (full virtualization if you are running on Intel VT-x and AMD-V or using support through partners like VMware for Xen 3.0)
- Supports both Intel* VT and AMD-V chipsets (SUSE Linux Enterprise Server 10 was the first operating system of any type to support Intel VT and AMD-V).
- Offers graphical (YaST) and command-line virtual machine management tools for easy VM administration and configuration.

Caveats

- Xen is *just* a hypervisor with limited management capabilities. It relies on third-parties for full management (examples: Virtual Iron, Platform, XENsource).
- IHV/ISV certification is needed for application support under XEN.

Lack of IHV/ISV certifications, along with the lack of real maturity in the management tool space, sometimes limits the use of XEN in the data center environment.

Supported Systems

On host computers running SUSE Linux 10 with Service Pack 1, the following SUSE Linux operating systems are supported as guests:

Operating System	Fully Virtual	Paravirtual
SUSE Linux Enterprise Server 10 SP1	Yes	Yes
SUSE Linux Enterprise Server 10		Yes
Open Enterprise Server 2 Linux	Yes	Yes
Open Enterprise Server 1 Linux	Yes	No
SUSE Linux Enterprise Desktop 10 SP1	Yes	Yes
SUSE Linux Enterprise Server 9 SP4	Yes	Yes
SUSE Linux Enterprise Server 9 SP3	Yes	
NetWare 6.5 SP7		Yes

Note: Novell does not support NetWare in full virtualization mode with Xen.

The following platforms can also operate as **unmodified** guest operating systems using Intel VT or AMD-V chipsets and the Xen hypervisor tools included with SUSE Linux Enterprise 10 with Service Pack 1:

- Microsoft Windows, including Windows NT, 2000, 2003
- Sun Solaris x86
- Red Hat Enterprise Linux 3 and 4

Enterprise-ready support is *planned* for the following **modified** virtual guest operating systems on SUSE Linux Enterprise 10:

- SUSE Linux Enterprise Server 9
- Red Hat Enterprise Linux 4 and 5
- Sun Solaris x86

Xen and NetWare

With OES 2 Xen, the NetWare 6.5 operating system can run inside a virtual machine as a virtualized guest operating system on top of the virtual machine monitor (the Xen hypervisor). The virtual machine monitor runs between the server hardware and the SUSE Linux operating system kernel and has the responsibility for allocating resources to the virtualized guest operating systems. It presents them with virtual machines that act like the guest servers' native architectures.

Administrators manage NetWare in a virtual machine much the same way they manage NetWare on a physical machine. Management tools such as ConsoleOne, iManager, and Novell Remote Manager all work the same. In addition, you inherit the ability to take advantage of Linux management utilities and console commands, because the virtual machine is running in a Linux environment.

One of the major benefits of running NetWare as a virtual machine is that you can run it on existing hardware or on chipsets specifically enabled for virtualization. Even if you choose to stay on existing hardware, and if your current NetWare servers have fairly low CPU utilization, you can probably host multiple NetWare virtual machines on one of your existing servers.

If preferred, you can take advantage of the newer 64-bit processors; you are no longer 32-bit bound. You can take full advantage of the extra processing power, added memory capabilities, and improved heat and energy savings offered by 64-bit dual-core and multi-core processors.

You can also host both Linux and NetWare as virtual machines on a single box. This can facilitate migration from NetWare to Linux by allowing you to preserve access to any NetWare-dependent applications and services while you transition your IT environment and skill sets to Linux. You can also

leverage a response file created during the installation of a NetWare virtual machine to create multiple NetWare virtual machines.

Xen and Other Operating Systems

Xen can also support *unmodified* operating systems such as Windows XP, but requires the computer running the virtualization host server to support hardware-assisted virtualization technology such as AMD* Virtualization or Intel* Virtualization Technology. Some guest operating systems hosted in full virtualization mode can be configured to run Xen-based drivers instead of operating-system-specific drivers. This improves performance dramatically in guest operating systems.

In other words, you can run Xen

- In paravirtualization mode with older CPUs and for best performance
- In full virtualization mode with Intel VT-x and AMD-V (to run WinXP, for example)

Xen management of VMs and Guest OSs is CIM-based and supports both local and remote management consoles. Some management capabilities have been provided via YaST (start up, shut down or suspend virtual machine operating system instances and migrate VMs from one physical server to another).

XEN Hardware Requirements (Virtualization Host)

In most cases, the hardware requirements for the virtualization host are the same as those for the SUSE Linux operating system, but additional CPU, disk, memory, and network resources may need to be added to accommodate the resource demands of all planned virtual machines. You need enough memory for the host plus additional memory to support each virtual machine that will run concurrently on the host server. For example, if you are installing one OES 2 Linux virtual machine, you need a minimum of 1 GB of memory: 5.12 MB for the host and 5.12 MB for the OES 2 Linux virtual machine. Just like physical machines, virtual machines perform better when they run on faster processors and have access to more system memory.

Note: A Xen virtualization host server can host virtual machines only for the x86-32 bit and x86-64 bit architectures. It does not create virtual computers for other system architectures such as Itanium*, or IBM* POWER (formerly IBM iSeries and IBM pSeries systems).

XEN Software Installation

Xen virtualization software can be installed during the initial installation of OES 2 Linux or added later. For best performance, only those applications and processes required for virtualization should be installed on the virtualization host.

If OES 2 Linux is already running, you can use one of the following methods from the desktop or command line to install the virtualization software:

- From the desktop, run YaST > Virtualization > Install Hypervisor and Tools. Complete the on-screen instructions and restart the computer.
- From a command line interface, enter `yast2 xen`. Restart the computer when finished.
- Copy the Xen virtualization packages to the computer. From a command line interface, enter `rpm -U package_names` to install the packages. Restart the computer when finished.

Installation Information

Installing Hosts. For complete information about installing the VM host and setting up VMs in general, see Virtualization: Getting Started, particularly section 3.0, "OES 2 Linux Virtual Machines."

Installing Quest Operating Systems. For complete information about installing NetWare 6.5 SP7 and OES 2 Linux as guest operating systems, see Section 2, "NetWare Virtual Machines" and Section 3, "OES Linux Virtual Machines," in the Virtualization: Guest Operating System Guide.

Managing NetWare on a Virtualized Machine. This Tech Talk written by Ken Baker and published in the Novell Connections Magazine provides background on Xen features enhanced for OES 2 as well as concise installation instructions.

Running OES 2 Services on Virtual Machines. For information about installing and running OES 2 services on virtual machines, see the links with the Virtualization page of the OES 2 Online Documentation.

Getting Started

If you decide to initiate a virtualization project, we recommend starting with a careful analysis of your current network as a first step. You'll need the following, at a minimum, for each server you are considering as a virtualization candidate:

- An application Inventory (including versions)
- A server Inventory (OS, processor, memory, utilization, ...)
- Performance data
- Anticipated future state (new/same hardware? new/same software?)

Then, for starters, ask questions like these:

- Why is virtualization being considered (maximum server utilization, cost of management, expansion/contraction, performance issues, prioritize resources, ...)?
- Are stakeholders on board?
- How many and what types of configurations will be consolidated or virtualized (combination of Development, QA, Applications); if so how many versions are you running, what updates/patches are needed, ...)?
- Which machines should be combined?
- What virtualization software should be used?
- What is the projected cost of implementation (staffing, design, testing, deployment,...)? Will the anticipated savings be worth it?
- What is the estimated cost of downtime (if any)?
- What processes need to be implemented or changed (testing, patching, deployment, ...)?
- What does the projected virtualization roadmap (task sequencing) look like?

Candidates for Virtualization and Consolidation

Many different types of servers can be virtualized including Linux, Windows, and NetWare. We recommend setting up a proof-of-concept XEN server to host these guests, placing many of your single purpose servers in this environment, and then rolling them to production when you are satisfied that this alternative meets your expectations.

You will need to take a close look at the current workloads of the servers you plan to consolidate. Understanding server workloads can help you prevent overloading the host with multiple servers of the same type and potentially running out of CPU, memory, or disk bandwidth.

- **Disk-intensive?** If you load up a single physical server with multiple virtual machines that are all extremely disk-intensive, you might use up the entire bandwidth of your disk array, or you

could run into contention problems if the virtual machines use the same fibre channel or iSCSI array.

- **CPU intensive?** Likewise, you might not want to add several servers that are CPU-intensive to the same virtual host.

The following types of servers lend themselves to virtualization:

Field Servers – Does your network include field offices that host a significant number of services with different configuration requirements? If so, each of these different configurations could be virtualized into a single XEN OES 2 Linux physical server.

Specialized Servers – Do you have several servers with single or specialized purposes? Most don't require a great deal of hardware resources. These servers and services could be virtualized onto a small number of powerful XEN OES 2 Linux physical servers.

General Purpose Servers – Does your data center include numerous servers that provide the same or similar services, for example, general purpose file and print servers? This situation presents an opportunity to consolidate existing disparate file and print services into a cluster environment. If the clusters are migrated to OES 2 Linux on new hardware, a significant increase in performance and scalability could be realized.

Novell Fast Track Virtualization Engagements

If you need help determining direction for your virtualization initiative, Novell Consulting offers a two-week Virtualization Fast Track Engagement that can help you investigate options.

Fast Track engagements typically focus on two basic environments, either Xen, VMware, or both, but options for considering other vendor software can be included as needed.

Fast Track Use Scenarios

The following use scenarios, whichever one best meets your needs, can be explored.

- Application virtualization - Provision applications in a full- or paravirtualized environment. Provide application portability and flexibility across hardware platforms.
- Consolidation - Consolidate physical servers and applications into one or more virtualized environments. Leverage excess data center capacity and improve response times by balancing computing loads across data center resources at peak times.
- Business Continuity - Provide fail-over for applications and/or hardware by moving a virtual machine from one box to another with only minimal disruption to service (not noticeable to service consumers).
- Migration - Migrate applications to another machine and/or operating system or from a physical to a virtual environment. This can include migrating server workloads to virtual farms so physical resources can be redeployed for other uses.
- Deployment - Deploy virtualized operating environments.

Basic Fast Track Activities

A typical Virtualization Fast Track engagement includes the following core activities:

- Interviewing stakeholders and gathering data to guide use scenario recommendations
- Gathering data to support a business case (preliminary goals, environment size, cost)
- Assessing the current state (virtual technology in use, benefits expected, potential issues)

- Exploring virtualization options (virtual machines, application virtualization, storage virtualization)
- Developing a list of vendors to be considered and/or setting up and hosting vendor demos
- Demonstrating core virtualization components
- Demonstrating virtualization hardware chip technology
- Making "next step" recommendations:
  - Implementing one of the virtualization environments (Xen, VMware, or other vendor platforms and management tools)
  - Server consolidation project
  - Application virtualization project (Oracle, DB2, etc.)
  - Server or application virtualization pilot
  - Business continuity assessment, pilot, or deployment
  - Detailed business case
  - Desktop virtualization assessment, pilot, or deployment
  - Further assessment of any of the areas of focus

Virtualization Software Vendors

This section provides an overview of only a few of the vendor possibilities; contact the vendors mentioned for complete information.

Note: Refer to the matrix on page 13 for a description of comparative features.

Software Vendor Options

The following are possible vendor options you might want to consider::

Virtualization Technologies

- Xen
- VMware
- SWsoft Virtuozzo
- Trigence
- Win4Lin
- Mellanox

Management Tools

- XenSource
- Virtual Iron
- PlateSpin

Virtualization Hardware & Chip Vendors

- Hardware: HP, Dell, and IBM
- Chip: AMD and Intel

Software Evaluation Metrics

Identify the metrics you will use to compare vendors and products. For example, consider the following:

- Are performance and scalability close to(or exceed) that for hosting on comparable physical hardware?
- Is virtualization software easy to deploy, manage, and support?
- Is memory overhead acceptable?
- Are the extent and nature of the changes required in the hosted Linux environment minimal (virtual hosting needs to be efficient)?
- Can fault isolation among virtual machines be enforced by the hardware?
- Can hardware resources assigned to an application container dynamically grow and shrink?
- Can each deployed service be configured and tuned to optimally host the service in question?
- How easy is it to manage and isolate workloads?
- Can guest OSs share (rather than own) a physical device and are they configurable?
- Are robust management tools included (or easily and inexpensively added) and are they easy to use?
- Is support for both local and remote management consoles available?
- Is management of the virtual machine and guest OSs CIM-based to allow a variety of management consoles from a number of vendors to be used?
- Is the product directory-enabled and policy-based; are policies easy to configure?
- Is the product currently available (or will be in your timeframe)?
- Can the virtual platforms being used or proposed be accommodated (Xen, VMware, Windows, etc.)?
- Is the product supported on the hardware you are using or will use?
- Is vendor support available and affordable?
- Are the price-points acceptable?

The following table is a sample evaluation matrix:

Can I ...	**Open Source**	**Commercial**	
	Xen	**VMware**	**Virtual Iron**
Run different application versions and/or OS versions on the same machine?	**X**	**X**	**X**
Host and consolidate Linux servers?	**X**	**X**	**X**
Host and consolidate Windows servers?	**Planned**	**x**	
Host and consolidate NetWare servers?	**x**	**x**	
Migrate a VM to a similar physical machine?	**x**	**x**	**NA**
Take advantage of Intel's VT & AMD architectures?	**X**	**X**	**?**
Run 64-bit guest OSs?	**X**	**X**	**X**
Make multiple servers look like one large server		**Up to 4 processors**	**Up to 16 processors**

Another sample matrix follows. Use it, or something similar, to help identify the vendor options most appropriate for your environment and use scenario (see the suggestions above).

Sample Vendor Comparison Matrix

Vendor	Description/Best Use...	Cost	Benefits
Xen	Xen™ is a virtual machine monitor for x86 that supports execution of multiple guest operating systems with unprecedented levels of performance and resource isolation.	Low	Novell Supported, included with SLES 10 and OESn2 Linux
XenSource, XenEnterprise http://xensource.com/	The original group that developed the XEN hypervisor has developed a management tool (XenEnterprise™) for Windows, Linux, and Solaris. As the first commercially packaged and supported Xen solution, it allows you to easily get Xen up and running. It's an integrated package that includes a comprehensive tool set to simplify deployment, provisioning and management of a Xen virtual infrastructure.	Medium	Advanced feature sets, built on open source XEN with extensive management modifications.
VMware http://www.vmware.com/	VMware ESX Server. ESX Server abstracts processor, memory, storage and networking resources into multiple virtual machines	H	Commercial offering and industry leader in virtualization. Most clients will be familiar with VMware. Price is sometimes considered prohibitive
Virtual Iron http://www.virtualiron.com/	Originally, Virtual Iron had its own hypervisor, but now supports the XEN hypervisor. It's one of the few companies that has Virtual Machine management capabilities that can be tested right now. Virtual Iron provides Xen-based, virtualization software solutions for creating and managing virtual infrastructure in the data center.	H	Xen based with Virtual Environments not para-virtualized. Virtual environments contain one single operating system which then keeps containers for other virtual environments .
PlateSpin http://www.platespin.com/	PlateSpin PowerRecon provides new levels of intelligence and visual analysis for consolidating and optimizing the data center by collecting hardware, software and services inventory with absolutely no manual effort or disruptive agent technology. Additionally, PowerRecon remotely gathers workload utilization statistics to provide a clear and concise picture of the application services running in the data center and how their resources are being used.	L	Provides consolidation matrix and is helpful in defining how many of "x" servers can be consolidated on "y" hardware. Useful in building business cases and roadmaps
Trigence http://www.Trigence.	Applications can be deployed, re-deployed or archived with Trigence in all IT	M	

Vendor	Description/Best Use...	Cost	Benefits
com/	environments whether physical or virtual. By separating applications from underlying infrastructure, Trigence simplifies application management allowing new, existing and legacy applications to move error-free within an OS family.		
SWsoft Virtuozzo http://www.swsoft.com/en/products/virtuozzo	Virtuozzo creates isolated, secure virtual environments on a single physical server enabling better server utilization, ensuring guaranteed resources and preventing applications from conflicting. Each VE performs and executes exactly like a stand-alone server; VEs can be rebooted independently and have users, IP addresses, processes, system libraries and configuration files.	M	Provides one operating system “container” concept virtualization. This provides virtual environments on a single operating system

You may also want to review these vendor offerings:

- Win4Lin: http://www.win4lin.com/
- Mellanox: http://www.mellanox.com/
- AMD: http://www.amd.com/us-en/

Virtualization Management Options

While YaST provides some management capabilities (creation, startup, shutdown, termination, and deletion), Xen relies on third-party tools for full management. Make sure management functionality is fully explored if you decide to investigate another vendor's software.

Key XEN management players include the following:

- **VMware** – VMware includes a mature and robust management solution. If you have consolidated Windows solutions, you will most likely have significant investments in VMware.
- **XenSource** – The original group that developed the XEN hypervisor has developed a management tool for Windows, Linux, and Solaris.
- **Virtual Iron** – Originally, Virtual Iron had its own hypervisor but now supports the Xen hypervisor. It's one of the few companies who have virtual machine management capabilities that can be tested right now.
- **Platform** – Virtual Machine Orchestrator. Its principal selling point is its ability to manage both VMware and XEN environments.
- **Cassatt** – Its Collage Product is presented as a “Service Level Automation Platform.” It has a cross-virtualization manager that supports VMware, XEN, and Microsoft Virtual Machines. Also included is a Web Automation Manager (WAM) to virtualize Java and Web Services.

Sample Virtualization Test Lab Setup

Before implementing virtualization in your production environment, we highly recommend setting it up in a test or development lab. Applications and services can be pre-staged or “incubated” in test environments and then quickly and easily deployed and redeployed into production. With virtualization technologies in place, it is the VM image that is managed and updated as opposed to the actual running server, allowing for effective, non-disruptive testing of patches and updates.

This section includes suggestions for configuring a test lab. Refer to the Xen or appropriate vendor documentation for installation and configuration instructions for both hosts and guests:

- **Installing Hosts.** See Virtualization: Getting Started, particularly section 3.0, "OES 2 Linux Virtual Machines."

  Note: If you are installing Open Enterprise Server (OES) 2 Linux, you need a network installation source for OES 2 Linux software including the SUSE® Linux Enterprise Server (SLES) 10 SP1 media and the OES 2 Linux add-on CD. For procedures to create the installation sources, see “Setting Up the Server Holding the Installation Sources” in the SUSE Linux Enterprise Server 10 Installation and Administration Guide.
- **Installing Quest Operating Systems**. See Section 2, "NetWare Virtual Machines" and Section 3, "OES Linux Virtual Machines," in the Virtualization: Guest Operating System Guide for information about installing NetWare 6.5 SP7 or OES 2 Linux as guest operating systems.

The lab environment should include the following:

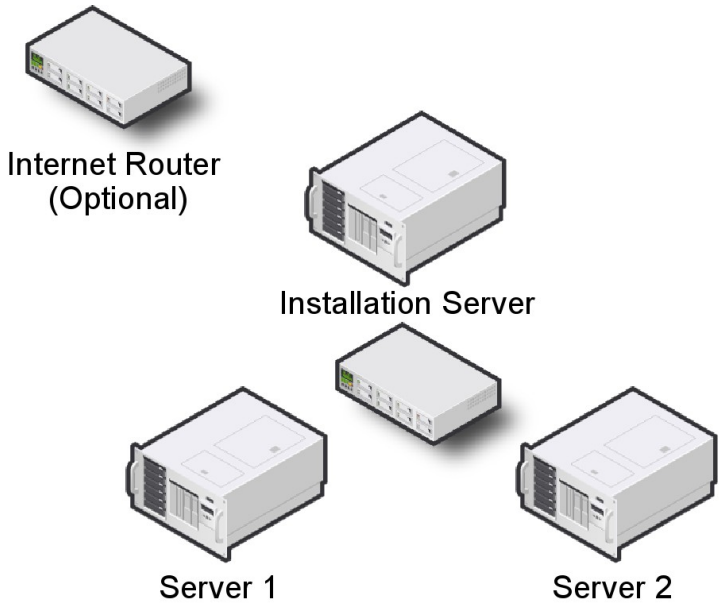
- An installation server that contains the base images (for Xen or VMware ESX, for example).
- Two additional bare metal servers that will be given one of the images (Xen, VMware, or other) depending on your preference.

All three servers need the following minimum configuration:

- Virtualization enabled CPU, either Intel-VT or AMD-V
- 200 GB storage
- 4 GB RAM

Installation Server

- SLES 10, SP1
- Configured as a DHCP server
- Configured as an FTP server
- Configured as a PXE and TFTP server
- Installation server images
  - SLES 10, SP1
  - Windows server
- XEN environment image
- VMware ESX (or other) environment image



XEN Environment Image

- Disk partitioning
  - 100 GB mount point /
  - 100 GB left unformatted
- OESn2 Linux installed with the XEN kernel

Virtual Machine 1

SUSE Version		SLES 10 SP1
Memory		512
Storage		8 GB Sparse File
Partitioning	•	6GB Root Files System
	•	2GB Swap
Software	•	Oracle Server Base

Virtual Machine 2

SUSE Version		SLES 10 SP1
Memory		512
Storage		8GB Block Device
Partitioning	•	6GB Root Files System
	•	2GB Swap
Software	•	As determined

VMware ESX Environment Image

- Disk Partitioning
  - 100 GB mount point /
  - 100 GB left unformatted
- VMware ESX Hypervisor

Virtual Machine 1

SUSE Version	SLES 10 SP1
Memory	512
Storage	8 GB Sparse File
Partitioning •	6GB Root Files System
•	2GB Swap
Software •	Oracle Server Base

Virtual Machine 2

SUSE Version	SLES 10 SP1
Memory	512
Storage	8GB Block Device
Partitioning •	6GB Root Files System
Software •	2GB Swap
Software	As determined.

Network

- Optional gigabyte router (configured to contain the DHCP services within the subnet)
- Gigabyte switch
- Cables
- Monitor, Keyboard, Mouse, and KVM switch

The test lab should be set up on an isolated network segment. If the imaging server will be running DHCP (as suggested in this example), it is very important that the lab switch not be connected to the production network.

Each of the machines should be connected to the central switch which needs to provide enough ports to connect laptops to the lab subnet in order to manage the environment.

Several protocols can be used: NFS, HTTP, FTP, CIFS

Determine how many NIC cards are in the server and whether you want them bonded. For additional information, see either of the following:

http://www.novell.com/coolsolutions/feature/15280.html

https://lists.innerweb.novell.com/pipermail/linux/2005-August/016440.html

File System

- Reiser or EXT3
- If you are using a logical volume management, either LVM or EVMS can be used.

Image the Servers

Create images of the two sever environments, once the machines have been configured.

1. Image the servers with imaging software. We recommend using Ghost for Linux.

   This product is a hard disk and partition imaging and cloning tool similar to "Norton Ghost" provided by Symantec.

   The Linux Ghost can be downloaded from:

   http://linux.softpedia.com/get/System/Hardware/Ghost-for-Linux-053.shtml

2. Boot the machines with the Linux Ghost CD.
3. Compress the images and store them on a local hard drive or transfer them to an anonymous FTP server or the Installation Server.
4. Set up the environment so it can be rolled back to the original state by copying a file over the existing configuration.
5. Boot the bare metal servers with the Linux Ghost CD or with PXE boot to connect to the Ghost images on the installation server.
6. Connect to the FTP server and select the correct ghost image to load.

Create Backup Images

1. Create back up images of all unique virtual machines on the installation server.
2. Be sure to create detailed note files for each.
3. Back up these XEN files:

   ```
   /var/lib/xen/images/{virtual machine name}
   /etc/xen/vm/{virtual machine name}
   ```

4. Back up VMware files as needed.

Sample Test Scenarios

Once your lab is set up, try some of these test scenarios:

- **Application virtualization** - Provision applications in a full- or paravirtualized environment. Provide application portability and flexibility across hardware platforms.
- **Consolidation** - Consolidate physical servers and applications into one or more virtualized environments. Leverage excess data center capacity and improve response times by balancing computing loads across data center resources at peak times.

  Take a few servers that are used for similar purposes and consolidate them on a single box using virtualization. Start with non-production boxes, and when you're comfortable with managing virtual servers, move to noncritical production areas.
- **Business Continuity** - Demonstrate how fail-over can be provided for applications and/or hardware by moving a virtual machine from one box to another.

  Using the iSCSI target initiation tools included in SUSE Linux Enterprise Server 10, configure a small cluster of two machines that share storage on a third machine. Migrate the virtual machine between the two physical machines to simulate a failover. We recommend starting

with a simple workload, like Apache, or testing a custom application that you may want to virtualize.

- **Migration** - Start by building some basic virtual machines using Xen on a single machine. If you have three machines available, you can test virtual machine migration**.**

  Demonstrate how applications can be migrated to another machine and/or operating system or from a physical to a virtual environment. Demonstrate migrating server workloads to virtual farms so physical resources can be redeployed for other uses.
- **Deployment** - Deploy the selected virtualized operating environment. Modify the host server to make Xen (or other virtualization software) the default boot kernel.
  - Limit the memory that dom0 uses.
  - Change the VM Activation mode of an existing VM.
  - Start and stop the VMs using the standard XEN tools.
  - Create an entirely new VM and install into it.
  - If third-party software is being used, make sure you test for any metrics that were used in choosing the software. Refer to the metrics section on page 12.
- **Development Servers** - If your organization often repurposes servers for the development of custom applications, try provisioning virtual servers for development environments instead of physical servers?

  Start by creating a primary server image for your development servers, and then whenever you need a new development server, simply create a new virtual machine and install your primary development server image.
- **Test Servers** - This scenario is like that for development servers, except you use a different primary-server image. Because you are using Xen paravirtualization, you will not lose performance on these test servers, and you may actually be able reduce the time needed to establish environments where your applications can be tested and validated.

Additional Resources

Linux information is widely available on both the Novell innerweb and the world-wide Web. The following list is representative but not all-inclusive.

Novell Product Documentation

SLES 10 Documentation: http://www.novell.com/documentation/suse10/index.html

- SUSE Linux 10 Start-Up Guide: http://www.novell.com/documentation/suse10/index.html?page=/documentation/suse10/startguide/data/bookinfo_book_startguide.html
- SUSE Linux 10 Reference Guide: http://www.novell.com/documentation/suse10/index.html?page=/documentation/suse10/adminguide/data/bookinfo_book_adminguide.html

Open Enterprise Server 2 Linux Documentation: http://www.novell.com/documentation/oes2

Open Enterprise Server 2: Virtualization

- **Installing Hosts.** For complete information about installing the VM host and setting up VMs in general, see Virtualization: Getting Started, particularly section 3.0, "OES 2 Linux Virtual Machines."
- **Installing Quest Operating Systems**. For complete information about installing NetWare 6.5 SP7 and OES 2 Linux as guest operating systems, see Section 2, "NetWare Virtual

Machines" and Section 3, "OES Linux Virtual Machines," in the Virtualization: Guest Operating System Guide.

- **Managing NetWare on a Virtualized Machine**. This Tech Talk written by Ken Baker and published in the Novell Connections Magazine provides background on Xen features enhanced for OES 2 as well as concise installation instructions.
- **Running OESn2 Services on Virtual Machines**. For information about installing and running OES 2 services on virtual machines, see the links in the Virtualization page of the OES 2 Online Documentation.

Vendor Documentation

- Vendor documentation for Windows operating systems--See Microsoft Web site
- Vendor documentation for RedHat operating systems--See RedHat Web site
- Vendor documentation for Solaris operating systems--See Sun Microsystems Web site

Xen Reference Materials

More information about Xen can be found at the following Web sites:

- Detailed instructions for configuring Xen virtual machines:
  - On the Novell Xen Technology Preview Web site, located at http://forge.novell.com/modules/xfmod/project/?xenpreview
- Xen home page with many additional documentation links:

  http://www.cl.cam.ac.uk/Research/SRG/netos/xen/index.html
- Xen mailing lists: http://lists.xensource.com/
- XEN Wiki: http://wiki.xensource.com/xenwiki/
- Official information for Xen users. The xen-doc-html package is required: /usr/share/doc/packages/xen/user/html/index.html
- Technical interface documentation. The xen-doc-html package is required: /usr/share/doc/packages/xen/interface/html/index.html

Note: Since Virtualization is an ever-changing environment, check these resources for the latest information in addition to those above:

- Novell Virtualization Technical Library: http://www.novell.com/linux/technical_library/virtualization.html
- Novell Virtualization Documentation: http://www.novell.com/documentation/vmserver/
- Novell.com virtualization site: http://www.novell.com/linux/virtualization/

Title	Description	Last update
SUSE Linux Enterprise Server 10 - Virtualization with Xen and Use Cases	**Novell Technical White Paper.** This white paper describes the benefits and use cases of Xen in the data center.	July 2006
Virtualization in the Data Center	**Novell Technical White Paper.** This paper defines virtualization terms and explains why virtualization matters. Xen and the Novell storage foundation are also discussed.	
The Xen™ Virtual Machine Monitor	University of Cambridge, Computer Laboratory Architecture. This is a follow-on to the 2003	2006

	SOSP paper "Xen and the Art of Virtualization." It describes some fairly major changes to the way Xen does I/O in the 2.0 release. Provides a list of document links to read to understand the architectural overview. Copyright - © 2006 University of Cambridge Computer Laboratory.	
SLES 10 Virtualization w/Xen	**Presentation**. Novell Virtualization Overview that covers the following: • Benefits of Virtualization • Metrics To Evaluate Virtualization • Tour of Virtualization Products • Xen • Using Xen • Inside Xen • Management Authored by Clyde Griffin and Charles Coffing of the Virtualization Platform Team. (69 slides)	Feb 2006
Virtualization Overview and Toolkit	**Web Campaign**. This site provides a description of virtualization and what virtualization provides: decoupling the physical hardware from the operating system so you can run multiple virtual machines, with heterogeneous operating systems in isolation, side-by-side on the same physical machine. You can register for a free VMware virtualization toolkit that contains solution white papers, customer case studies, and evaluation software.	Summer 2006
Xen Virtualization and Linux Clustering	**Web Articles.** Linux Journal articles by Rick Mauer. **Part 1:** http://www.linuxjournal.com/article/8812 Part 2: http://www.linuxjournal.com/article/8816	Not dated
Virtualization in Xen 3.0	**Web Article**. Linux Journal article by Rami Rosen.	Not dated
Linux Virtualization with Xen	**Web Article**: Article by Kris Buytaet posted at Linux devcenter.com.	Jan 2006
Ziff Davis Media Web Site	**Ziff Davis Media Web Site presented by Dell and Intel**. This site provides links to Technology Briefs, eSeminars and other resources you'll need to implement virtualization solutions. The site is dynamic with new materials submitted by Dell, Intel, VMware, Altirus, and EMC added continuously. You can sign up to receive automatic updates when new briefs are available.	Summer 2006

Enabling Business Agility through Virtualization	**Dell Technology Brief.**	Summer 2006
Better Business Protection through Virtualization	**Dell Technology Brief.** Discusses how virtualization solutions can aggregate industry standard servers and their attached network and storage into unified resource pools to help make business continuity comprehensive and affordable. (2 pages).	Summer 2006
Virtualization Gets Real	**Dell Technology Brief.**	Summer 2006
The Great Virtualization Migration	**Dell Technology Brief.** Cites Welch Foods as a use case and discusses how virtualization can deliver "dramatically higher levels of operational efficiency by helping to: • Improve server utilization rates • Streamline development and test environments • Support legacy applications more effectively" (2 pages)	Summer 2006

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