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Technical and commercial comparison of Citrix XenServer and VMware

Citrix XenServer and VMware vSphere are two leading server virtualization platforms. This document provides a technical and commercial comparison of XenServer and vSphere, including installation and maintenence, OS support, high availability, disaster recovery and other important virtualization concerns that should be weighed when exploring virtualization solution options.

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Overview

This document provides a technical and commercial comparison of Citrix®
XenServer™ and VMware® vSphere™, two of the leading server virtualization
products on the market. As this comparison will illustrate, XenServer is a
powerful and feature-rich alternative to VMware and distinguishes itself in
number of areas—including its open architecture, performance, storage
integration and total cost of ownership.

- **Citrix XenServer** is a free virtualization platform based on the
  open-source Xen® hypervisor and includes XenCenter™, a
  multi-server management console with core management features
  such as multi-server management, virtual machine (VM) templates,
  snapshots, shared storage support, resource pools and XenMotion™
  live migration. In addition, Citrix offers advanced management
  capabilities in Citrix Essentials™ for XenServer™ product line. Citrix
  Essentials for XenServer is available in two editions, Enterprise
  and Platinum.

- **VMware vSphere** is a server virtualization platform that includes
  the VMware ESX™ hypervisor and associated management tools.
  vSphere is available in three different editions: Standard, Advanced
  and Enterprise Plus. VMware is also offering an Enterprise
  edition of vSphere for a limited time. vSphere servers are managed
  from vCenter Server, VMware's multi-server management console.
  vCenter Server is purchased separately from vSphere.

Comparisons

System architecture

Both products feature bare metal or *Type 1* hypervisor technologies that are
installed directly onto physical servers without requiring a host operating
system (OS). It is widely accepted that this bare-metal approach offers
significantly better performance and manageability than solutions reliant on
a host OS, such as VMware GSX Server® (GSX) and Microsoft Virtual Server.

VMware ESX binary translation
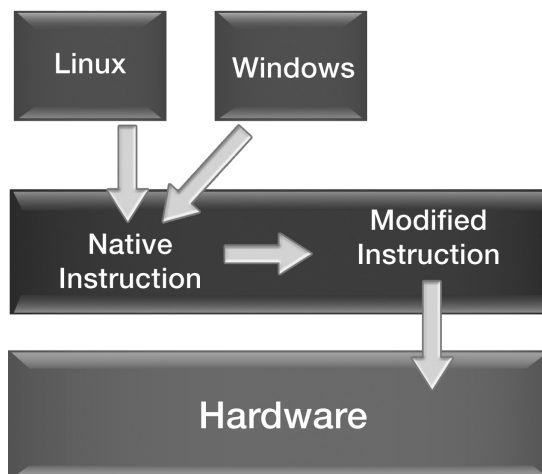
VMware ESX has been on the market the longest and its first generation architecture predates virtualization-aware operating systems (including most Linux® distributions and Windows Server® 2008) and processors (i.e., Intel® VT, AMD-V™). ESX's approach to virtualization can best be described as binary translation: each OS request to the processor is intercepted and translated into a virtualization-friendly instruction. For example, a halt request from the OS to the processor will ensure that instead of suspending execution for the entire system, only the specific VM is suspended, releasing resources to other VMs. In this manner, ESX tricks the guest OS into thinking it is running on physical hardware. Due to the need to perform so much of this work in software, ESX is a very sophisticated and complex system.

As the first layer of software interacting with the hardware, VMware has made considerable investments in the development of proprietary device drivers to support the variety of network and storage hardware available on commercial servers. As new hardware devices become available, VMware-specific drivers need to be written to support them.

The architecture of XenServer is quite different from VMware, as XenServer development coincided with the availability of virtualization-aware processors and operating systems. XenServer is built on the open-source Xen hypervisor, which is the basis for nearly two dozen commercial virtualization products and the engine powering the world's largest virtualization deployment, the Amazon™ Elastic Compute Cloud™. Instead of using binary translation like VMware, XenServer uses a combination of paravirtualization and hardware-assisted virtualization. XenServer was the first solution on the market to employ paravirtualization, which allows a guest OS to be fully aware that it is being run on virtualized hardware. This collaboration between the OS and the virtualization platform enables the development of a simpler, leaner hypervisor, as well as highly optimized performance. Linux distributions were the first OSs to be paravirtualized for Xen. Today, XenServer supports paravirtualization with a number of Linux distributions, including Red Hat® Enterprise Linux®, Novell® SUSE, Debian®, Oracle® Enterprise Linux and CentOS. For guest operating systems that can't be fully paravirtualized, such as Windows®, XenServer is designed to leverage hardware virtualization assist technologies, available on today's Intel and AMD™ processors (Intel VT and AMD-V).
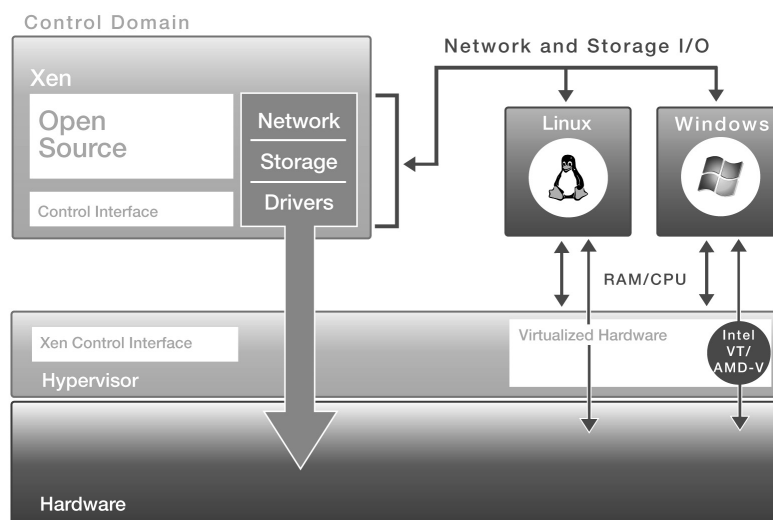
XenServer hypervisor architecture

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Despite initially downplaying the merits of paravirtualization, VMware has begun to adopt it within ESX in the form of its VMI technology. The release of a VMI performance white paper further highlights VMware's belief in paravirtualization and its superiority over binary translation. Thus far, only a few Linux operating systems (specific versions of SUSE and the community-supported Fedora) are enabled to run with VMI on vSphere.

The XenServer approach to device drivers is also significantly different than VMware. With XenServer, all virtual machine interactions with the hardware are managed through the Domain 0 control domain, which itself is a specially privileged virtual machine running on top of the hypervisor. XenServer Domain 0 is shown in the upper left-hand side of the illustration above. Domain 0 runs a hardened, optimized instance of Linux. It's important to recognize that to the administrator, Domain 0 is part of the overall XenServer system and requires no additional installation or management. Domain 0 enables XenServer to leverage standard open-source Linux device drivers, resulting in extremely broad hardware support. Because of this design, XenServer can even run on laptops or workstations—systems on which VMware's proprietary drivers are much less likely to function.

Interestingly, the design of Microsoft® Hyper-V™ has been modeled closely after XenServer. The key difference between Hyper-V and XenServer is the operating system used in the control domain. Whereas XenServer uses a hardened, optimized instance of Linux, Hyper-V uses a hardened, optimized version of Windows Server 2008.

Installation, configuration and administration

XenServer has a straightforward installation process, often referred to as the 10 minutes to Xen experience. XenServer is installed on the host systems using a CD or network-based installation process. The XenCenter GUI-based administration console is then installed on any Windows PC or server. System configuration information is kept in an internal data store within the XenServer control domain and is replicated across all servers that are managed together (forming a resource pool) to maintain high availability of the core management services. As a result of this architecture, a separate database server is not required for the core management functions.

Similar to XenServer, the VMware ESX hypervisor is installed on the host servers. VMware uses vCenter Server for multi-server management and configuration. vCenter Server runs as a Windows service on a separate management server and requires a third-party database for storage and management of host system configurations. For redundancy and availability of the core management services, VMware recommends the addition of clustering software such as its vCenter Server Heartbeat add-on product.

XenServer and VMware are also available onboard the firmware of many x86 servers, including those from HP and Dell®. In this case, no pre-installation is required.

Guest OS support

VMware and XenServer both support the most popular Windows and Linux OSs, including Windows XP, Windows Vista®, Windows 2000 Server, Windows Server 2003, Windows Server 2008, Red Hat Linux, SUSE Linux and others. In addition, VMware ESX supports some flavors of BSD®, Sun™ Solaris™ and Novell Netware®. VMware and XenServer are both certified for Windows according to the requirements of the Microsoft Server Virtualization Validation Program (SVVP).

Storage integration

Storage is one of the most important considerations for server virtualization deployments. Both solutions offer support for storage of VMs on local disks, iSCSI or Fibre Channel-based Storage Area Networks (SAN), or Network Attached Storage (NAS). Use of a SAN or NAS is required for advanced features of each platform, such as live migration and high availability.

VMware typically leverages its proprietary VMFS file system for storage, although raw disk options are available. VMFS is the default storage system for VM files, with both local and shared (SAN or NAS) storage. VMFS is a clustered file system that enables advanced features such as VMotion and Storage Vmotion. When used with SANs, use of VMFS allows VMware to take control of certain storage functions, including provisioning and snapshotting, no matter what vendor's array is being used. Storage Vmotion enables live migrations of VMs from one array to another without downtime.

XenServer takes a completely different approach to storage. XenServer does not impose its own file system on storage systems but, instead, leverages the native storage capabilities more directly. For example, with a file-based shared storage system such as NFS, XenServer VMs are stored directly using Microsoft VHD (Virtual Hard Disk) format. With block-based storage such as iSCSI or Fibre Channel SANs, XenServer extends VHD with the open LVM (Logical Volume Manager) standard for volume management. The administrator is completely shielded from the underlying implementation details through the XenCenter Storage Repository creation wizard (shown below).
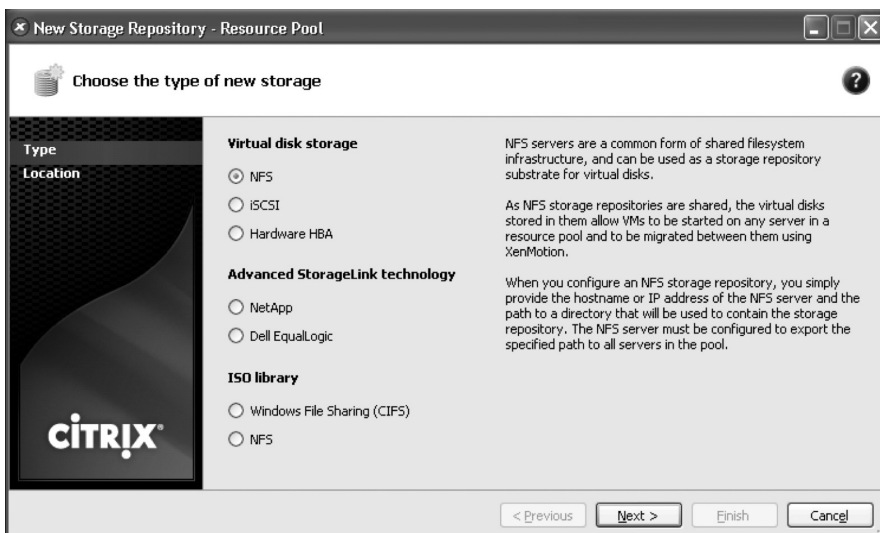
XenServer Storage Repository Wizard

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The unique storage integration features of XenServer come in the form of StorageLink™. StorageLink enables the virtualization administrator to directly leverage features of industry-leading arrays such as those from HP, NetApp®, Dell EqualLogic and EMC®. For example, a VM snapshot request within XenCenter will offload this task to the SAN, through an interface with the SAN vendor's API. In this manner, StorageLink can optimize performance and permit virtualization administrators to use the advanced features of the array exactly as they were intended, including snapshots, clones and thin provisioning. In addition to vendor-specific APIs, StorageLink supports the ANSI standard for storage management, SMI-S (Storage Management Initiative – Specification), enabling easy integration of many storage vendors' equipment.

Virtual machine backup and recovery

XenServer and VMware both offer VM snapshot capability for basic backup and recovery needs. Support for traditional agent-based backup solutions is also available and both vendors maintain ecosystem partnerships with a variety of backup software providers. XenServer extends the agent-based approach for Windows VMs through the enablement of a XenServer-specific Volume Shadow-copy Service (VSS) provider. When a backup agent (such as Symantec™ Netbackup™) makes a call to the Windows VSS provider, the XenServer VSS provider intercepts it and redirects it to perform a disk-level snapshot. This disk-level snapshot is a differential copy (not a full copy) and can take as little as five seconds to complete. In this manner, regular backups are optimized for performance since the snapshot has minimal performance implications for the XenServer host.

VMware offers a feature called Data Recovery in vSphere for backup of virtual machines. Data Recovery is a plug-in for vCenter Server that schedules regular disk snapshots for virtual machines. Some customers see this as an alternative to traditional agent-based approaches; however, Data Recovery does not offer application-level awareness which is often cited by customers as a reason to use agent-based solutions for workloads such as SQL Server, Oracle, Exchange and Active Directory.

Disaster recovery

Disaster recovery (DR) involves the duplication of virtual server infrastructure and data at remote facilities for recovery in case of an event that makes the primary site inaccessible. Virtualization simplifies disaster recovery in many ways, as server workloads packaged as virtual machines are easier to transport and restart on remote systems.

XenServer and VMware both support multi-site deployments, whereby VMs can be made available in primary and DR sites. In each case, the virtualization solution relies on SAN-based replication technologies to keep VM files and configuration data current at a backup location. VMware offers Site Recovery Manager, an add-on product that is essentially a workflow engine for orchestration of DR for systems virtualized with ESX. Similarly, Citrix Essentials™ for XenServer™, Enterprise Edition includes Workflow Studio™, which can complement XenServer for automation of DR for both virtualized and physical servers.

High availability and fault tolerance

High availability enables virtual machines to be restarted on another physical host, should the original host running the VM unexpectedly fail. This can reduce the amount of downtime for the workload, as well as eliminate the need for administrative intervention. Both VMware and XenServer have high availability features that offer granular policies governing the behavior of specific VMs after a host failure. VMware also includes fault tolerance, a feature that maintains mirrored instances of virtual machines running on separate hosts. In the event of a host failure, the mirrored instance can maintain continuity of the workload. Fault Tolerance is supported for VMware virtual machines with 1 vCPU.

XenServer can be augmented with third-party products to deliver VM fault tolerance, including best-of-breed offerings from Marathon Technologies and Stratus.

VM load management

VM load management has two important aspects. First, it ensures that a VM is started up on the host that is most suitable for the VM workload. Second, it ensures ongoing management of the location of VMs running in a pool of host servers.

XenServer includes a feature called Workload Balancing (WLB). Workload Balancing captures data such as CPU, memory, disk I/O and network I/O on the hosts and virtual machines to guide the initial and ongoing host location for virtual machines. There are two optimization modes for WLB: optimize for performance and optimize for density. Optimizing for performance ensures that minimum performance thresholds are maintained, whereas optimizing for density ensures reduced power consumption by placing VMs on the minimum number of hosts.

VMware offers DRS, a feature that guides the initial VM placement as well as semi- or fully-automated load management of VMs using its Distributed Resource Scheduler (DRS) feature. DRS does not enable much customization of the load management algorithm and is based solely on CPU and memory utilization.

System maintenance

XenServer and VMware both require some regular maintenance to apply software updates and patches. Because VMware and XenServer both offer live migration features, patching and updates to the hypervisor can be performed without incurring any downtime for VMs. VMware's product includes automated patching for the hypervisor as well as guest OS. As a complex and sophisticated software system, VMware requires significantly more patching and updates than other system software such as the BIOS or device drivers. The VMware VI 3.5 updates site lists hundreds of patches that have been issued since the product was launched in December 2007 and the automated update process is touted by VMware as a way of managing the application of these updates. By contrast, Citrix has issued just five hotfixes for XenServer 4.0 since its release in August 2007 and includes automated update features in XenCenter for applying system updates. XenServer does not include patching features for guests, instead, leaving this task for the variety of products from OS vendors (and their ecosystem partners) or the provisioning services feature of the product.

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Provisioning services

XenServer includes unique provisioning services features for virtual machines. This technology allows users to set up a library of server workloads (operating system images, applications, configurations) and stream them on-demand to multiple virtual or physical servers within the datacenter. Provisioning services enable multiple virtual machines to share a single workload image, resulting in streamlined administration as well as significant storage savings. Provisioning services are ideal for server farms such as XenApp, Web servers and virtual desktops.

Dynamic workload streaming can be used to rapidly deploy server workloads to the most appropriate server resources (physical or virtual) at any time during the week, month, quarter or year. This is particularly useful for applications that may be regularly migrated between testing and production environments or for systems that might require physical deployments for peak user activity during the business cycle. Provisioning services are a unique feature that simply must be seen to be fully appreciated—there is nothing else on the market quite like it.

At a glance: XenServer and VMware

	XenServer 5.5	VMware vSphere 4.0
Pricing model	Per server: No restriction on number of processors	Per processor: Penalizes use of more powerful servers and higher consolidation ratios
Bare-metal deployment	Free	Yes
P2V and V2V migration tools	Free	Yes
Multi-server management	Free	Yes: vCenter Server $6-$8k extra
High availability of core management services	Free	Yes: vCenter Server Heartbeat $12-$16k extra
Shared storage support	Free	Yes: Standard Edition and higher
Resource pools	Free	Yes: Standard Edition and higher
VM snapshots	Free	Yes: Standard Edition and higher
Real-time performance monitoring	Free	Yes: Standard Edition and higher
Live motion	Free	Yes: Advanced Edition and higher
VM backup enablement	Free	Yes: Advanced Edition and higher
8 vCPU support	Free	Yes: Enterprise Plus Edition only
Disaster recovery enablement	Free	Site Recovery Manager: $2k extra, per processor
High performance for Windows	Free	Virtualization Review called VMware "the pokiest" and XenServer "the Porsche."
High performance for Linux	Free	VMware has limited support for paravirtualization
High performance for XenApp	Free	Tolly Group: XenServer beats VMware by 41%
Maintenance requirements	5 patches for XenServer 4.0 since release in August 2007	Hundreds of patches for VI 3.5 since release in December 2007
VM high availability	Yes, Enterprise Edition	Yes: Standard Edition and higher
Historical performance monitoring	Yes, Enterprise Edition	Yes: Standard Edition and higher
Administrator alerts	Yes, Enterprise Edition	Yes: Standard Edition and higher
StorageLink	Yes, Enterprise Edition	Nothing comparable
Provisioning services for VMs	Yes, Enterprise Edition	Nothing comparable
VM load balancing	Yes, Enterprise Edition	Yes: Enterprise Edition and higher
Lab management	Yes, Platinum Edition	Lab Manager: $1,500+ extra, per processor
Stage management	Yes, Platinum Edition	Stage Manager: $1,500+ extra, per processor
Role-based administration	Coming soon[1]	Yes; Standard Edition and higher
Memory overcommit	Coming soon[1]	Yes; Standard Edition and higher
VM fault tolerance	Products from Marathon Technologies and Stratus	Yes: Advanced Edition and higher (for VMs with 1 vCPU)

[1] Statements in this document about future functionality do not represent a commitment to deliver these features in any generally available product. Pricing, packaging and delivery dates of any new features discussed or presented in this document have not been determined.

Sample pricing comparisons

The following example shows sample cost comparisons of XenServer and a VMware-based solution for the consolidation of physical servers.

Example 1: Consolidation of 40 physical servers to 5, using four-processor servers and an 8:1 consolidation ratio.

5 Servers – XenServer 5.5		5 Servers – VMware vSphere 4.0*	
Capabilities: Multi-server management, resource pools, XenMotion, HA, workload balancing		**Capabilities:** Multi-server management, resource pools, vMotion, HA, DRS	
5x Citrix XenServer	Free	vCenter Server + 3 Year Gold Support:	$7,670
5x Essentials for XenServer, Enterprise:	$12,500	vCenter Server Heartbeat, 3 Yr Gold Support:	$15,347
1 Year support contract:	$1,500	vSphere Enterprise, 3 Yr Gold Support : (20 processors)	$88,304
Subscription Advantage Renewal:	$325 per host		
Total 3-year cost:	**$20,250**	**Total 3-year cost:**	**$111,321**

Example 2: Consolidation of 100 physical servers to 20, using two-processor servers and a 5:1 consolidation ratio.

20 Servers – XenServer 5.5		20 Servers – VMware vSphere 4.0*	
Capabilities: Multi-server management, resource pools, XenMotion, HA, workload balancing		**Capabilities:** Multi-server management, resource pools, vMotion, HA, DRS	
20x Citrix XenServer	Free	vCenter Server + 3 Year Gold Support:	$7,670
20x Essentials for XenServer, Enterprise:	$50,000	vCenter Server Heartbeat, 3 Yr Gold Support:	$15,347
1 Year support contract:	$1,500	vSphere Enterprise, 3 Yr Gold Support : (40 processors)	$176,608
Subscription Advantage Renewal:	$325 per host		
Total 3-year cost:	**$67,500**	**Total 3-year cost:**	**$199,625**

*Pricing from VMware online store as of June 2009

Conclusion

Just a few years ago, customers looking for server virtualization solutions had limited options. The server virtualization market has entered a new phase, where powerful and capable solutions such as Citrix XenServer offer a compelling and feature-rich alternative to VMware. As this white paper has shown, XenServer surpasses VMware in a number of areas—including its open architecture, performance, storage integration and total cost of ownership.

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