



The XenServer™ Product Family

The Next Generation of Server Virtualization

Virtualization Choices for Every Server

The business case for virtualization is based on an industry-wide focus on server consolidation, a need for enhanced flexibility and responsiveness of IT assets, and high availability of critical infrastructure applications. But in spite of an impressive growth rate, server virtualization has yet to become main stream. Today's proprietary virtualization products are largely deployed in test and development and for consolidation of non-performance critical production workloads, but are rarely if ever used for business-critical roles. Mainly because the virtualization market place until now has lacked open solutions, offered limited hardware vendor support and operating system vendor support, and lacked the tools to enable effective virtual servers.

The virtualization marketplace is undergoing a dramatic transformation that will see server virtualization ubiquitously deployed within the next few years. One major catalyst of this change is the Xen™ open source hypervisor, developed and maintained by the founders of XenSource, and delivered to market by XenSource and its operating system vendor (OSV) partners. Another major catalyst is with the hardware vendors and the next level of support in virtualization enable chips from Intel and AMD discussed later in this paper.

The XenServer™ product family, Citrix's packaged offerings of Xen virtualization for Windows and Linux guests, is poised to move virtualization to the mainstream and re-shape the economics, performance and openness of the enterprise virtualization market. Today enterprise server virtualization users demand high

performance virtualization for multi-OS workloads. The products deliver an open virtualization platform offering IT a choice of best-of-breed components at every layer of the virtualization stack at a price point for volume adoption. The XenServer product family (including XenServer Express Edition™, XenServer Standard Edition, and XenServer Enterprise Edition™) is transforming the traditional server infrastructure offering unparalleled savings with superb hardware compatibility and driver support. Built by the team that developed Xen, Citrix's offering is thmarket's first real choice for server virtualization

Virtualization Done Right

In server virtualization, the virtualization layer (known as the hypervisor) manages the server hardware, safely sharing it between multiple concurrently executing virtual machines, each of which hosts a virtualized server instance, or guest. XenServer products, via the Xen hypervisor, take advantage of new technologies to deliver server virtualization without compromise in performance, price, or compatibility.

First generation hypervisors present each virtual machine with an emulated hardware layer that offers the guest operating system the illusion of a standard server with well-known hardware devices. When a running guest attempts to control the hardware using privileged instructions, the hypervisor stops execution and emulates the legacy hardware device, hiding the real hardware underneath. It then patches the operating system code of the running guest, in real time, to make its future hardware accesses virtualization safe. Of course, this complexity impacts performance, much as emulated floating-point computation did prior to the implementation of hardware floating-point support.

The Xen hypervisor introduced a powerful virtualization architecture, called paravirtualization (also known as "enlightenment"), pioneered by the XenSource founders.

Widely acknowledged as "the right architecture" for virtualization, paravirtualization delivers near "bare metal" performance to virtual machines while ensuring that resources are fairly shared between them. It is the key to widespread adoption of virtualization as a standard component of the enterprise software stack.

In Xen, guests interface with the hypervisor via an efficient, low-level API, known as the hypercall API, rather than through hardware emulation. This allows the hypervisor and operating

system to co-operate to optimally virtualize the underlying hardware and schedule guest CPU and I/O, resulting in tremendous performance, security and portability advantages.

A key advantage of Xen paravirtualization is that it can re-use the hardware qualification and driver certification of existing operating systems. The driver stack is simply a standard operating system, certified on the hardware by the system vendor, with specific privileges to perform I/O to real hardware on behalf of other guests. This use of an off-the-shelf operating system requires no need to port drivers into a proprietary console operating system. The XenServer product family supports the same set of server hardware, storage and I/O devices as any Enterprise Linux distribution.

Another important catalyst to virtualization is Intel's VT and AMD's AMD-V (codename Pacifica) enabled chips, which simplify virtualization of the processor. Paravirtualization is ideally suited for this next generation advance hardware assist for virtualization from Intel and AMD. Basically, virtualization will be accessible at the chip level in their newest processors, indicating a major shift in the adoption of server virtualization. Since late 2006, all new servers have shipped with hardware acceleration for virtualization, signaling the end of emulation. Both Intel VT and AMD virtualization will provide a processor-level hardware-accelerated vector that automatically enters the hypervisor (akin to a "hardware hypercall") when a running guest executes a privileged operation. Intel and AMD will also offer new instructions allowing Xen guests to benefit from fast paravirtualized I/O.

These two innovative technologies, essentially, the arrival of virtualization-aware operating systems and virtualization-ready processors, signal the mainstream-readiness of virtualization, and Citrix is poised to deliver the resulting benefits with Xen and the XenServer products

Paravirtualization: Supported by Every x86 Operating System

XenSource and its OSV partners have collaborated closely to ensure that the benefits of paravirtualization will be delivered to market in every x86 OS. Novell has integrated Xen support into its SUSE Linux Enterprise Server (SLES) 10 product, and has already announced preview support for SLES 9. Red Hat supports Xen in Red Hat Enterprise Linux (RHEL) 5, as well as providing guest support for RHEL 4. Other Linux distributions are also delivering support for Xen. Sun has announced that it will include support for Xen in a service pack for Solaris 10. As a result, Xen will soon be pervasively supported as a standard component of the open source operating system software stack.

With 80% of the server market running Windows, the XenServer product family makes it easier and feasible for Windows IT professionals to adopt the Xen architecture, bringing the

advantages of paravirtualization to the market today. Supported by Microsoft, the products share the same core architectural design as the forthcoming Windows Server Virtualization (code-named Viridian) which will be offered with Windows Server Code Name "Longhorn". Citrix Xen, in partnership with Microsoft, ensures a seamless and interoperable virtualization solution for Windows IT professionals around this open architecture. The Windows Server Code Name "Longhorn" will be paravirtualized, or "enlightened," extending the list of virtualization-aware operating systems for the new generation of technology.

The XenServer Product Family: Next Generation Multi-OS Server Virtualization

The XenServer product family delivers to the market the power of Xen paravirtualization in a full featured, enterprise ready, and easy-to-use virtualization solution. It is the industry's first open, enterprise class virtualization platform aimed at the multi-OS, volume virtualization market. It incorporates the Xen hypervisor, easy to use installers for Xen and guests, Physical to Virtual (P2V) tools for virtualization of existing server operating system installations, and a powerful multi-server management console in a single affordable package.

XenServer products: Multi-OS virtualization platform

- Supports both paravirtualized and fully virtualized guests
- Uses Intel VT or AMD-V hardware virtualization assist for Windows guests
- All guests use fast paravirtualized I/O
- Will support Xen Project virtual disk format (QCOW) and Microsoft VHD format for interoperable VM storage
- Windows hosted on XenServer products is supported by Microsoft

The XenServer product family brings all of the benefits of Xen paravirtualization to the multi-OS virtualization market, meeting the IT department need for support of legacy Windows and Linux, and the upcoming releases of operating systems with paravirtualization support from Microsoft, enterprise Linux vendors, and Sun.

The products leverage the hardware assisted virtualization features of Intel VT and AMD-V processors to virtualize Windows. The offering includes premium performance enhancements for legacy operating systems, offering the benefits of Xen paravirtualization to every guest virtual server.

Uniquely, XenServer products are extensible by Citrix Xen's software and hardware vendor partners such as Microsoft, IBM, Red Hat, Citrix, Sun, Intel and AMD, allowing the delivery of value added features for storage, manageability, security and other platform extensions within the virtualization stack.

“Ten Minutes to Xen”

To let users install Linux based virtual machines quickly, XenServer Enterprise Edition and XenServer Express Edition include a Debian Sarge based guest template “ready to go”. Enterprise Linux based guests can be installed in two ways – through physical-to-virtual migration (P2V) from an existing server installation, or by doing a fresh install from a Linux repository. Once a virtual machine built on any supported operating system is deployed as a virtual machine, it can be cloned, exported and imported into the same or a different server using the graphical and command line interfaces available in all of the products.

Windows guests may be installed for all three products from CD or DVD media, or from ISO images that are either copied onto the server or mounted remotely via the network from an NFS or SMB/CIFS file server.

To perform P2V of a Linux server for server consolidation, the user simply boots the target machine containing the existing Linux installation with the product CD. The software will discover all installed operating systems, prompting the user for guidance on which installation(s) to virtualize. For each selected installation, the P2V tool moves the image to the XenServer, Enterprise Edition or XenServer Express Edition server and automatically creates a Xen virtual machine.

An alternative way to install a Linux guest is to use a local or network repository. Xen Enterprise Edition installs the guest from the repository into an empty virtual machine, parameterized by the user. The P2V process is implicit in this installation, since the repository will contain a non-virtualized guest kernel.

The user is prompted to assign CPU, memory, network and storage resources to a guest during installation. Guest storage is

managed as a set of LVM volumes and can span multiple physical disks and include SAN-hosted volumes. Networked (NFS/CIFS) storage is accessible to guests once they are running.

For Windows guests, P2V conversion is performed using products offered by Citrix Xen technology partners. Information about use of these products in conjunction with any XenServer product can be found on the Citrix website.

The XenServer products include a powerful management console, which is the control center for a XenServer Enterprise Edition server farm and the hosted virtual servers. XenServer Express Edition users can use the Administrator Console to connect to each of their hosts one at a time, perform management operations, disconnect from that host, and connect to the next host they wish to manage. XenServer, Standard Edition and XenServer, Enterprise Edition incorporate multi-server management capability, allowing the same Administrator Console to display, monitor and manage multiple hosts and their virtual machines at the same time

The Java console is easily installed on any client that the user wants to use to manage the servers and their guest virtual machines. The console provides tools for VM lifecycle management, as well as monitoring capabilities and wizards to install guests, manage their resources, and access guest consoles.

When the user installs a guest, the OS image is deposited into a new volume created on the target server. The user completes the installation of the VM from the GUI using the VM creation wizard, which takes the user through the tasks of assigning virtual CPU and memory, managing storage and virtual networking. Once installed, a guest can be started, stopped, rebooted and cloned with a single click of the mouse.

When used in conjunction with XenServer and XenEnterprise, the console displays the managed servers in a tree view. For each physical server, it displays the set of VMs installed on the server together with a live view of each VM's state, its resource usage and performance. Clicking on a host allows the user to manage the XenServer product family instance on that host. Clicking on any of the guest VMs on that server allows the user to manage the guest, access its graphical or text console, and monitor detailed historical performance metrics for CPU, memory, disk I/O and network I/O rates.

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Xen Ecosystem Delivers Virtualization on Every Server

With the delivery of Xen 3.0 in December 2005, the Xen Project achieved a major milestone – an open source hypervisor that outperforms the market leading products for server virtualization and that has changed the future of virtualization by offering a powerful new architecture – paravirtualization – that is supported, or soon will be supported, in all x86 operating systems.

Xen support is offered by Novell, Red Hat, and other enterprise Linux distributions, including Debian, Ubuntu, Mandriva and others. Sun has announced support for Xen as a service pack to Solaris 10, and Microsoft supports Windows on XenServer products.

The XenServer product family, which supports Windows Server 2003, Windows XP, and Windows 2000, is XenSource's Microsoft-endorsed offering to the Windows IT market. Microsoft and XenSource, through a partnership, provide comprehensive customer support for Windows guests on the XenServer product family. Future versions of the products will let users import guests from Microsoft Virtual Server, saved in the Microsoft Virtual Hard Disk (VHD) format. XenSource and Microsoft are collaborating on support of paravirtualized Linux guests on the Windows Hypervisor, and broadly on interoperability across their virtualization product lines.

Citrix is committed to offering best of breed product choices at all layers of the virtualization stack and is based on an open, interoperable product offerings from vendors in the Xen ecosystem. An investment in XenServer products is an investment in the next generation of server virtualization.

About Citrix

Citrix Systems, Inc. (Nasdaq:CTXS) is the global leader and the most trusted name in application delivery infrastructure. More than 200,000 organizations worldwide rely on Citrix to deliver any application to users anywhere with the best performance, highest security, and lowest cost. Citrix customers include 100% of the Fortune 100 companies and 98% of the Fortune Global 500, as well as hundreds of thousands of small businesses and prosumers. Citrix has approximately 6,200 channel and alliance partners in more than 100 countries. Annual revenue in 2006 was \$1.1 billion.

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