Consolidation through Virtualization
with Sun x64 Servers

Today's IT organizations are being asked to perform a nearly-impossible juggling act. Deliver more applications but at lower cost. Increase performance but reduce the number of systems to manage. Buy the best server for the job but maintain the flexibility to change which operating systems you support at a moment's notice. Support Microsoft Windows today, the Solaris™ Operating System tomorrow, and keep your Linux skills well-honed. Fortunately, Sun has a solution that helps increase flexibility and reduce risk. With Sun Fire™ x64 servers and Sun Blade™ modular systems powered with AMD Opteron™ processors, you can choose which enterprise operating system to run today — Solaris, Linux, Windows — and change your mind tomorrow. But consolidate multiple applications and different operating systems onto the same server? It's an innovative way to do more with less, and it's straightforward with virtualization technologies available from Sun and its partners (Figure 1).

Highlights

- Consolidating multiple applications onto a smaller number of servers helps IT organizations cut cost and complexity, increase agility, and reduce data center power and cooling costs.
- Sun x64 servers give IT organizations the choice of running the Solaris Operating System, Linux, or Microsoft Windows, and the flexibility to re-deploy the moment their needs change.
- IT organizations can consolidate multiple Solaris 10 OS and open source applications onto a single server using Solaris Containers partitioning technology.
- They can consolidate any combination of Solaris 10 OS, supported Linux, and supported Microsoft Windows applications onto a single server using VMware Virtual Infrastructure technology.

Doing More with Less

Almost every enterprise depends on its IT organization to support applications that make it run. But in today's economy, almost every business is cutting costs to the bone in order to deliver products and services more cost-effectively and efficiently than the competition. This business climate translates into pressure for IT organizations to do the same.

IT organizations are tasked to cut cost and complexity while delivering high-performance, high-availability, business-critical applications that perform at lightning speed.

These demands translate into a unique set of challenges for IT organizations:

- Reducing capital expenses by using a smaller number of larger, powerful, more cost-effective servers
- Reducing operating expenses by managing a smaller number of servers and by supporting a small, core set of enterprise operating systems
- Increasing server utilization and reducing power and cooling costs by deploying multiple applications onto a single server, sharing resources and reducing the number of wasted CPU cycles

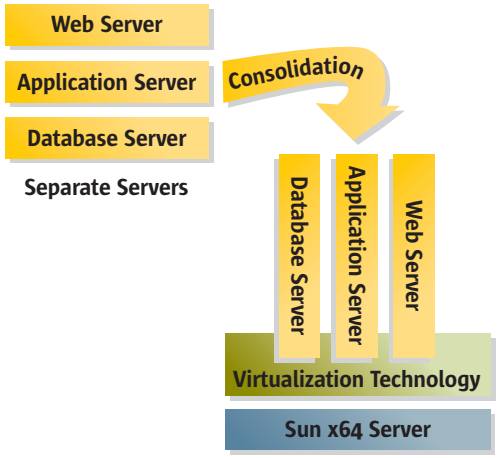


Figure 1: Consolidation through virtualization allows different applications to run in secure, isolated environments on a single server platform —like Sun x64 servers

- Optimizing flexibility and protecting investments by choosing servers that can be used to support one application and operating system today and support a different combination tomorrow
- Raising availability levels with local replication and reliable servers equipped with redundant components
- Provide for continued operations by distributing applications geographically

Virtualization and Consolidation

In the 1990s, a key strategy in designing Internet architectures was to decompose applications into separate components. Each component was replicated for availability, hosted in its own security domain (usually a dedicated server), and tuned for optimal performance. This resulted in a large number of 1 RU and larger servers deployed across data center environments, each contributing to inefficiency:

- Each server was sized to handle the maximum expected workload, leaving its CPU (and other resources) underutilized most of the time.
- Each 1U server required its own infrastructure including power supplies and cooling fans, resulting in higher initial capital costs and ongoing operational costs than with larger servers offering better economies of scale.
- Each server contributed to the number of systems to maintain, licenses to track, and operating system instances to support.

Virtualization and consolidation techniques have evolved since the 1990s to the point where today they can be used together to support Internet architectures that are logically decomposed but which physically share the same infrastructure. This helps IT organizations achieve the same security, availability, and performance benefits of decomposed architectures while realizing a whole new level of efficiency. Virtualization and consolidation

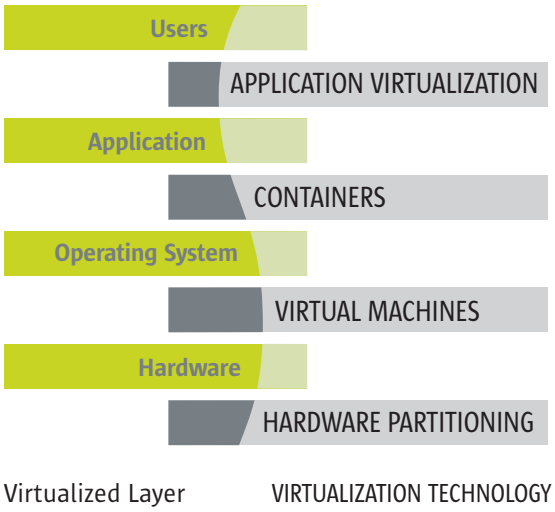


Figure 2: Virtualization and partitioning technologies (grey) fit between layers of the hardware and software stack (green), giving the illusion of a dedicated environment to the layer above.

are two key tools that help IT organizations do more with less.

Consolidation

Consolidation is the strategy of moving multiple applications from separate servers onto a smaller number of shared servers. This technique is used by IT organizations wishing to leverage the efficiency and cost effectiveness of larger, more powerful servers.

In some cases, multiple applications can be consolidated onto a single application instance. For example, one database management system can support different applications through a set of disjoint tablespaces. A Web server's virtual hosting capability allows it to support multiple sites. In many cases, however, each application targeted to share a single server requires its own application instance. For example, separate Web server instances are needed to support development, staging, and production Web sites so that developers can change the environment without affecting the business application.

Virtualization and Partitioning

Consolidation is the goal, but virtualization and partitioning are the means by which multiple applications or application instances can share the same platform and resources without interfering with each other. For example, virtualization allows multiple Apache Web server instances on the same server each to have their own *httpd.conf* configuration file, each in a separate, virtualized environment. Virtualization allows applications to access the resources they are authorized to use — and not exceed the boundaries of their security domain. Virtualization also allows IT organizations to manage resources like CPU, memory, and network bandwidth for greater utilization, and dynamically adjust resource allocation. This helps IT organizations with the flexibility they need to respond quickly to rapidly-changing workloads.

Virtualization begins with a single environment and creates the illusion of multiple ones. Virtualization can take place at several levels, but regardless of level the effect is that the application or the guest operating system itself has the illusion that it 'owns' its environment. Four different virtualization techniques are used in products from Sun and its partners today (Figure 2):

- *Hardware Partitioning* creates multiple, secure, electrically-isolated domains on a

single server platform. Sun's Dynamic System Domains technology is available on mid-range and high-end UltraSPARC® processor-powered servers.

- *Virtual Machine Software* creates an illusion using software that each operating system has its own dedicated hardware — despite the fact that each operating system only 'owns' a part of the hardware platform. Virtual machine technologies include the open-source Xen, Microsoft Virtual Server, and VMware GSX Server (with the next release named VMware Server). VMware Virtual Infrastructure, in which ESX Server is the key component, is the virtual machine technology highlighted in this brief.
- *Containers* partition a single operating system instance to give each application the illusion that it has its own environment and its own dedicated set of resources. BSD Jails is one example of partitioning technology, and Solaris™ Containers is the technology highlighted in this brief.
- *Application Virtualization* refers to the fact that many applications support virtualized environments themselves. Most Web servers, for example, can host multiple virtual sites concurrently, each with their own root and resources such as Common Gateway Interface (CGI) scripts. Sun Java™ System Web server, for example, supports multiple virtual Web sites.

Virtualizing the Data Center

For years, Sun has been developing technologies to help IT organizations reduce cost and complexity by enabling them to manage their resources as a single, centrally-managed, flexible, dynamically-allocated pool. This strategy helps data centers reduce the number of systems they manage and increase utilization, helping them be more cost effective. It helps them to leverage the economies of scale of powerful, reliable servers, storage, and networking technologies — even for the smallest applications. And it helps IT organizations more easily align with their companies' business objectives while keeping up with the rapid pace of change.

Virtualizing Layer by Layer

At each layer in the IT infrastructure, Sun helps to virtualize resources, helping IT organizations increase reliability, resource utilization, flexibility, and security. Sun's virtualization strategy extends to three key infrastructure layers: storage, servers, and the network:

- Many Sun StorEdge™ storage products support a centrally-located and managed pool of storage that can be securely partitioned and allocated to servers and applications on demand.
- For years, Sun's high-end servers have supported Dynamic System Domains partitioning technology that allows IT organizations to treat their servers as a single pool of resources that can be allocated to a set of secure, electrically-isolated domains.
- The Sun Secure Application Switch virtualizes the network, allowing IT organizations to allocate resources including hardware-accelerated TCP termination and re-assembly, packet-filtering, load-balancing, and SSL encryption to multiple, securely isolated virtual switches in order to support virtualized service switching.

Leading-Edge Technologies for Everyone

Sun has had a long-held philosophy of developing leading-edge technologies for its high-end products and pushing them down to mid-range and entry-level products over time. Nowhere is this philosophy more evident than in its server virtualization technologies. Sun first offered Dynamic System Domains only in its high-end servers, and now offers similar technologies in many of its mid-range offerings. Today, Solaris Containers support multiple virtual Solaris 10 OS environments to run on the same server, bringing high-end partitioning technologies to single-processor servers, and across the range of platforms that Sun supports, from its potent UltraSPARC® processor-based products to its x64 servers with AMD Opteron processors.

Unprecedented Opportunity with Sun x64 Servers

The Sun x64 server product line makes Sun a "One-Stop Shop" for IT organizations needing to support multiple operating systems, and also for those wishing to consolidate multiple applications onto a smaller number of servers.

Consolidation is the goal. Virtualization and partitioning are the means. The end result is lower cost, greater agility, and less complexity.

Sun x64 Servers

Sun x64 servers run existing 32- and 64-bit operating systems and applications with blinding speed. Built around AMD Opteron processors and the AMD DirectConnect Architecture, bandwidth between CPUs, memory, and I/O devices is optimized and latency is minimized — speeding both system and application performance. With choices ranging from one Single-Core CPU to 40 Dual-Core CPUs in a single system, Sun x64 servers are an ideal platform for server consolidation, with customers able to choose the horsepower they need to support many or only a few consolidated applications on a single server.

All Sun x64 servers can be equipped with single- or dual-core CPUs, with the latter integrating two microprocessors on a single chip to double the performance of the corresponding single core CPUs (based on measurements of Sun Fire™ V40z servers with single- and dual-core processors at the same clock rate).

Table 1: Sun Offers a Range of Consolidation Platform Options

Feature	Sun Fire X4100 server	Sun Fire X4200 server	Sun Fire V40z server	Sun Fire X4600 server	Sun Blade 8000 modular system
AMD Opteron Processors (Single or Dual-Core)	Up to two (1-4 cores)	Up to two (1-4 cores)	Up to four (1-8 cores)	Up to eight (4-16 cores)	Four Dual-Core processors per server module (8 cores) Up to 40 per server (up to 80 cores)
Number of Processor Sockets	Two	Two	Four	Four, upgradable to Eight	Four per Sun Blade x8400 server module
Memory	Up to 32 GB (16 GB per socket)	Up to 32 GB (16 GB per socket)	Up to 64 GB (16 GB per socket)	Up to 128 GB (16 GB per socket)	Up to 64 GB per server module
Internal Storage	Up to 4 hot-pluggable 2.5-inch SAS disk drives with onboard RAID 0 and RAID 1	Up to 4 hot-pluggable 2.5-inch SAS disk drives with onboard RAID 0 and RAID 1	Up to 6 hot-swappable Ultra 320 SCSI disk drives with onboard RAID 0 and RAID 1.	Up to 4 hot-swappable 2.5-inch SAS disk drives with onboard RAID 0 and RAID 1	Two hot-swappable SAS or SATA disk drives with onboard RAID 0 and RAID 1
Integrated Networking	Four 10/100/1000 Base-T Ethernet ports	Four 10/100/1000 Base-T Ethernet ports	Two 10/100/1000 Base-T Ethernet ports	Four 10/100/1000 Base-T Ethernet ports	Up to four Network Express Modules per server module, for up to 8 10/100/1000 Base-T Ethernet Ports
Expansion	Two 64-bit PCI-X MD2 low-profile expansion slots	Five 64-bit PCI-X MD2 low-profile expansion slots	Seven internal PCI-X expansion slots	Two 64-bit PCI-X slots, four x8-lane and two x4-lane PCI Express slots, eight low-profile PCI expansion slots	Up to two PCI-Express ExpressModules per server module
Rack Units	1 RU	2 RU	3 RU	4 RU	19 RU
Power and Cooling	Redundant, hot-swappable power and cooling	Redundant, hot-swappable power and cooling	Redundant, hot-swappable power and cooling	N+1 redundant, hot-swappable power and redundant, hot-swappable, cooling	N+N (3+3) redundant hot-swappable power and redundant, hot-swappable cooling

Even better, dual-core Sun x64 servers help reduce the complexity, operational cost, space, and power requirements faced by today's IT organizations through increased density and more efficient use of power. When coupled with the Solaris 10 OS, Sun's dual-core x64 servers unleash their true performance potential by delivering near-linear scalability, multi-fold performance gains with existing applications, and greater system utilization with Solaris Containers. In addition, because Sun develops new versions of the Solaris OS at the same time it develops its server technology, virtualization and consolidation with the Solaris OS is typically available before third-party software on the latest Sun servers.

Improving Data Center Efficiencies

One rack of Sun Fire X4100 servers populated with Dual–Core AMD Opteron processors requires 24 percent less power than the Intel Xeon DP processor-based solution required to provide a similar number of CPU cores. When scaled up to a compute farm of 10,000 servers, the annual savings is $510,000 for the Sun solution over the Intel-based solution, when the cost of total power consumption and HVAC is considered.

A Range of Consolidation Options

Sun offers a range of consolidation options to customers through a rich set of offerings in its x64 server product line (Table 1). These options support small, medium, and large consolidation efforts through 1, 2, 3, 4, and 19 RU platforms that support from 1-80 CPU cores each:

- The Sun Fire X4100 server (Figure 3) is a two socket, compact, 1 RU server that can support up to four CPU cores and up to 32 GB of memory.
- The Sun Fire X4200 server is a two socket, 2 RU unit that provides additional expansion capabilities over the Sun Fire X4100 server,

including up to seven PCI-X expansion cards.

- The popular Sun Fire V40z server a four socket, 3 RU system that hosts either 2 or 4 AMD Opteron processors for a total of 2-8 CPU cores. The server can support up to 64 GB of memory, and up to 6 Ultra 320 SCSI disk drives with a built-in RAID controller. Availability can be improved further by configuring the server with dual, redundant, hot-swap power supplies.
- The new Sun Fire X4600 server has the capability to grow with the consolidation task. It can be configured with either four or eight sockets, with the capability to support 4, 8, or 16 processor cores. In a compact, 4 RU package, the server supports up to 128 GB of memory and up to 4 hot-swappable 2.5 inch SAS disk drives with onboard RAID controller. Redundant power and cooling is standard on this server, and a wealth of expansion options make it an excellent platform for consolidation activities requiring significant amounts of external I/O.
- The Sun Blade™ 8000 modular system (Figure 4) is the ultimate consolidation platform, with tremendous flexibility to grow with the size of the consolidation task, and the cost and power efficiency of centralized power and cooling. The Sun Blade 8000 modular system gives you a 19 RU platform that supports up to 80 processor cores on up to 10 Sun Blade X8400 server modules, with built-in, hot-swappable, redundant power and cooling. The server provides expansion slots for each server module to connect to four NetworkExpress and two PCI-Express ExpressModules, giving IT organizations the ability to purchase and deploy only the needed peripheral connectivity required for each server module. Each server module acts as an independent server, with four Dual-Core AMD Opteron processors, up to 64 GB of memory, and two hot-swappable 2.5 inch SAS or SATA disk drives with onboard RAID 0 and RAID 1. The modular expansion capabilities attached to each server module allows up to 8 Gigabit Ethernet interfaces and up to four x8-lane and two x4-lane PCI-Express interfaces per server module. The server modules themselves do not use on-board cooling fans, further enhancing reliability and serviceability.

Sun Fire X4600 Server

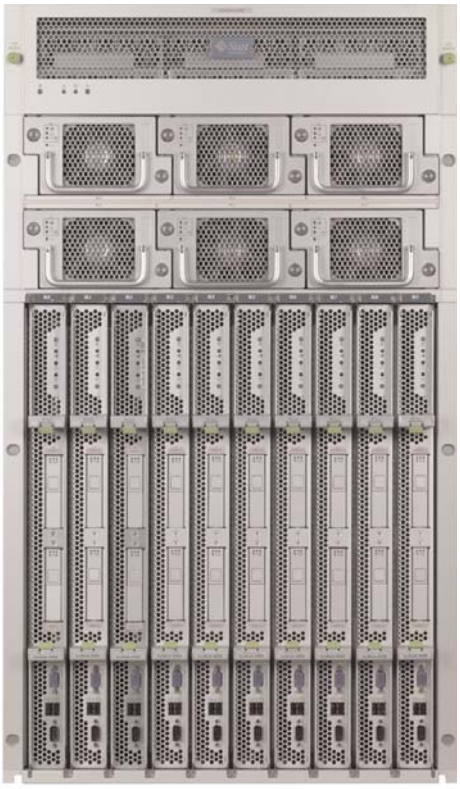
Sun Fire V40z Server

Sun Fire X4200 Server

Sun Fire X4100 Server

Figure 3: Sun Fire X4100, X4200, V40z, and X4600 servers support the Solaris OS, Linux, and Microsoft Windows, as well as Solaris Containers and VMware Virtual Infrastructure — two key options for consolidation through virtualization.

All of these x64 server platforms include integrated lights-out management through additional 10/100 Mbps Ethernet interfaces that typically connect to a data center management network. Sun's newer servers include Intelligent Lights-Out Management (ILOM), which allows the server platform to be logically extended to provide access to peripherals such as CD, DVD, and floppy drives on remote systems. This feature makes it easy to load software into virtualized systems without the need to enter the data center.



Sun Blade 8000 Modular System

Figure 4: With the ability to host up to 80 AMD Opteron processor cores in only 19 rack units, and support the Solaris OS, Linux, and Microsoft Windows, as well as Solaris Containers and VMware Virtual Infrastructure, a Sun Blade 8000 modular system fully populated with 10 Sun Blade X8400 server modules is the ultimate consolidation platform.

Sun's server capabilities can be complemented with Sun software technologies to improve availability even further. Part of the Sun Java™ Enterprise System, Sun Java™ System Cluster Server supports multi-node clusters.

One-Stop Shop

With the option to run Solaris, Linux, or Microsoft Windows on Sun x64 servers, IT

organizations have the flexibility to use one vendor to meet a wide variety of requirements. They can purchase one set of servers and storage, deploy them for one purpose today, and re-deploy the same hardware with a different operating system choice the moment their needs change. And with virtualization technology, they can run all three operating systems on the same platform at the same time.

Ideal Consolidation Platform

Sun x64 servers are the ideal platform for application consolidation. Because Solaris, Linux, Windows, and VMware Virtual Infrastructure all run on x64 processors in native mode, applications can run at full processor speed, without the need for time-consuming processor-set emulation. With three operating system choices, customers have the greatest flexibility and investment protection. Of the virtualization and partitioning technologies discussed on page 2, two stand out as best-of-breed technologies for use with Sun x64 servers: Solaris Containers and VMware Virtual Infrastructure.

Partitioning the Operating System with Solaris Containers

Solaris Containers combine operating system partitioning with fine-grained resource controls to allow servers to be partitioned at sub-CPU granularity without having to replicate the operating system image itself (Figure 5). Solaris Containers provide a virtualized Solaris 10 Operating System image including a unique root file system, a shared, read-only set of system executables and libraries, and whatever resources the root administrator assigns to the container at creation time. Solaris Containers can be booted and shut down just like any instance of the Solaris 10 OS, and rebooted in seconds if the need arises. Unlike virtual machines, which must intercept every single interrupt and allocate it to the right OS instance, Solaris Containers support main-

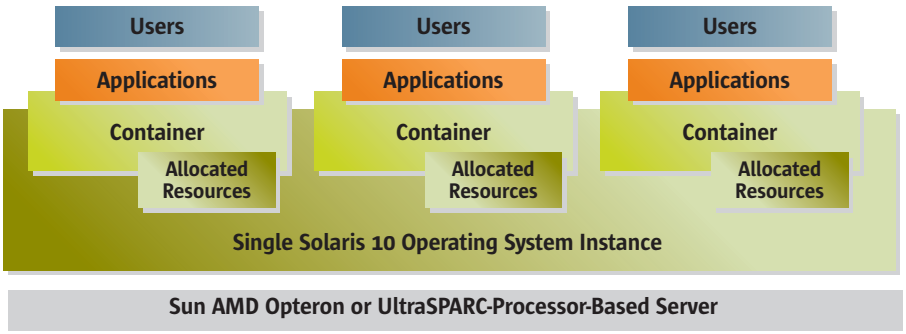


Figure 5: Solaris Containers combine operating system partitioning with fine-grained resource controls, offering a secure, isolated environment for each consolidated application.

frame-level partitioning capabilities with almost zero overhead.

Operating System Partitioning

Solaris Containers provide a set of up to 8192 virtualized environments per Solaris 10 OS instance, each container appearing to users, administrators, and applications as independent, isolated systems. A global administrator can create containers, allocate resources to them, and boot them as if they were an operating system instance. Once booted, Solaris Containers provide a secure environment that includes:

- A virtual platform containing a unique root, shared user, and other administrator-configured file systems — plus network interfaces, inter-process communication objects, console devices, and sub-container resource management facilities;
- System identity settings including host name, time zone, RPC domain, and locale;
- Secure isolation from other containers enforced by the kernel and capable of preventing a process within a container, even if compromised, from escalating privileges to compromise another container;
- Fault isolation that restricts the propagation of software faults to a single container. If an error does cause a container to fail, it can reboot in only a few seconds because the single operating system instance running on the server remains intact.

A Solaris Container hosting a Web server might be allocated an IP address with rights to bind to port 80, and a disk device containing a file system for the Web site content. The Web server cannot see or access any resources not allocated to its container. If the Web server fails, or its security is penetrated by an intruder, it cannot affect other containers or the applications running in them.

Fine-Grained Resource Control

Solaris Resource Manager software gives administrators almost unlimited flexibility to assign and isolate resources to specific containers. Resource Manager can be used to allocate resources to multiple applications within a single container. Across multiple containers, Dynamic Resource Pooling allows administrators to allocate discrete pools of resources such as CPUs to specific containers. Administrators can dynamically change the content of resource pools manually or automatically on a rule basis. For example, an additional CPU can automatically be added to a container when its utilization exceeds 80 percent — and all without rebooting.

The Fair Share Scheduler supports dynamic resource allocation, allowing proportions of resources — such as fractions of a CPU — to be allocated to containers. When resources like CPUs and memory are dynamically allocated, resource-capping controls can be used to set

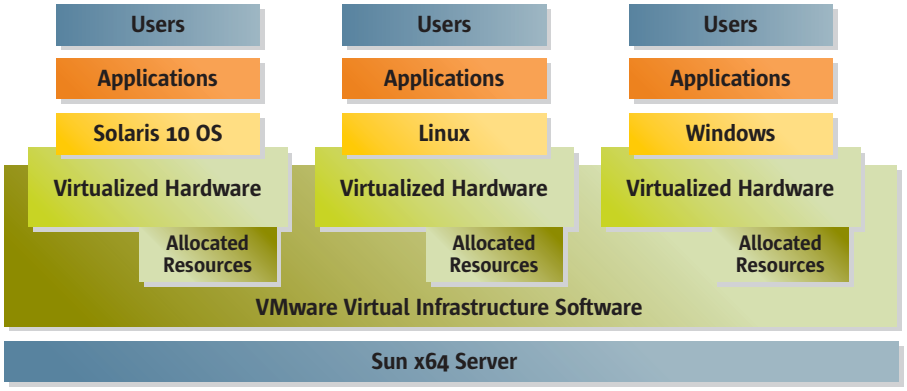


Figure 6: Each virtual machine supported by VMware Virtual Infrastructure software supports an idealized hardware environment, including CPUs, memory, disk, and even BIOS.

limits on the amount of resources consumed by specific containers. Finally, Solaris IP Quality–of-Service can be used to manage network bandwidth used by multiple containers, helping administrators to maintain specified QoS levels in a consolidated environment.

Virtualizing the Hardware with VMware Virtual Infrastructure

VMware Virtual Infrastructure, comprised of ESX Server and VirtualCenter, is virtual machine technology for partitioning, consolidating, and managing systems in mission-critical environments. VMware ESX Server provides a highly-scalable virtual machine platform with advanced resource management capabilities, all which is managed through VMware VirtualCenter.

Rather than virtualizing a single operating system instance, VMware Virtual Infrastructure works one layer lower, providing a layer of abstraction between the server hardware and the software that runs on it (Figure 6). This allows the product to support a different class of consolidation requirements than Solaris Containers — namely support for applications requiring kernel-level isolation and supporting multiple operating systems on the same server. By virtualizing the hardware, a single system running VMware Virtual Infrastructure can support a heterogeneous environment including multiple instances of the Solaris 10 OS, and different instances and versions of Linux, FreeBSD, Novell Netware, and Microsoft Windows. VMware Virtual Infrastructure implements abstractions that allow hardware resources to be allocated to multiple workloads in fully-isolated environments.

Idealized Hardware Platform

VMware ESX Server runs directly on supported Sun x64 servers to provide a secure, uniform platform for deploying, managing, and remotely controlling multiple operating system instances. Hardware interfaces, such as device drivers, enable hardware-specific service delivery while hiding hardware differences from other parts of the system. The virtualization layer provides an idealized hardware environment and virtualizes underlying physical resources.

By presenting a platform-independent x86-architecture hardware environment appropriate for each guest operating system, ESX Server makes it easy to move virtual environments from machine to machine without having to exactly match CPUs, disk drivers, and network interfaces. Platform-independent virtual environments also make it possible to support operating systems and applications no longer supported by hardware vendors. For example, ESX Server can be configured to support Microsoft Windows NT guest operating systems, enabling IT organizations to migrate existing applications from obsolete hardware platforms to state-of-the-art Sun x64 servers.

Each virtual platform consists of idealized CPUs, memory, disk and network interfaces. Each virtual environment has its own CPU or CPUs, with virtualization of the 32-bit x86 architecture complete down to the registers, translation lookaside buffer, and other control structures. Most instructions are directly executed on the physical CPUs, allowing compute-intensive workloads to run at near-native speed. While each guest operating system has the illusion that it owns up to 16 GB of contiguous memory, ESX Server actually manages memory so that physical memory in a virtual machine may actually be un-mapped or paged out. All of this takes place without the knowledge of, and without interfering with, the guest operating system. Disk devices are presented to the guest OS as a SCSI drive connected to a SCSI adapter. This is the only disk storage controller seen by the guest operating system, virtually eliminating the need to load potentially de-stabilizing disk drivers into the OS. Each disk device is implemented with a flat file, the format of which is the same regardless of what type of device it actually resides on, including SCSI, RAID, NAS, iSCSI, and Fibre Channel devices. ESX Server can support up to four virtual network cards within each virtual machine, each of which has its own MAC address and one or more IP addresses. A virtual switch mechanism allows administrators to configure when to pass network traffic from one VM instance to another, and when it exits the server to a physical switch.

Table 2: Consolidation and Virtualization Guidelines

If you have...	Then...
Multiple applications running on the Solaris 10 OS	Consolidate using Solaris Containers
Multiple open-source applications	Run each application in its own Solaris Container
Mixture of Solaris OS and Linux applications	Migrate Linux applications to the Solaris OS and consolidate using Solaris containers or Consolidate them unchanged onto one or more servers running Virtual Infrastructure
A number of applications running on the Solaris 10 OS, Linux or Microsoft Windows	Consolidate onto one or more servers running VMware Virtual Infrastructure

Granular Resource Management

The resource manager in ESX Server uses a proportional share mechanism to allocate CPU, memory, and disk resources across multiple virtual machines. Network bandwidth is controlled with network traffic shaping. Minimum and maximum percentages of a single physical CPU's processing power can be specified for each virtual machine. ESX Server also allows CPU shares and restricting a virtual machine to run on a certain set of physical CPUs (CPU scheduling affinity). Similarly, administrators may specify minimum and maximum memory sizes, as well as memory shares, for each virtual machine.

Guest Operating System Choice

One of the benefits of virtualizing the hardware platform is that different guest operating systems and different versions of each operating system can co-exist on the same platform, giving IT organizations a flexible range of consolidation options. In the ESX Server architecture, guest operating systems interact only with the standard x86-compatible virtual hardware presented by the virtualization layer. This provides the capability for ESX Server to support any x86-compatible operating system. In practice, however, ESX Server supports a subset of x86-compatible operating systems that are tested throughout the product development cycle. VMware documents the installation and operation of these guest operating systems and trains its technical personnel in their support.

The list of supported guest operating systems is available at *http://www.vmware.com /pdf/vi3_systems_guide.pdf* and includes the Solaris 10 OS and multiple versions of Red Hat Linux, SuSE Linux, FreeBSD, Novell Netware, and Microsoft Windows operating systems.

VMware VirtualCenter Server

VMware VirtualCenter Server acts as a central management console for servers running ESX Server. The server directs actions on individual virtual machines and ESX Server hosts themselves. VirtualCenter Server is a single Microsoft Windows service that runs continuously in the background, performing monitoring and management activities.

Consolidation through Virtualization and Partitioning

Virtualization with VMware Virtual Infrastructure and partitioning with Solaris Containers gives Sun customers a flexible set of choices for consolidating multiple applications onto a single server. Putting these technologies to work in an IT environment opens up a whole new realm of possibilities.

Complimentary Workloads

IT organizations can deploy a set of applications onto servers based on their complimentary resource requirements. For example, an On-Line Transaction Processing (OLTP) system might occupy most of a server's resources during the daytime while customers are placing orders. At night, long-running Data Warehousing queries can absorb unused CPU cycles, helping to increase overall IT resource utilization and efficiency.

Complimentary Web applications can be deployed in similar manner. A news site, for example, can be deployed in secure virtualized environments across a number of servers dedicated to different purposes. When a major news story results in an astronomical increase in activity, the stand-by Web servers can be pressed into service simply by adding them to a load-balanced service group. The IT organization can respond to a spike in workload without the delay of having to wheel in new servers and load operating system and application software onto them.

Flattening Architectural Layers

A high-availability, three-tier Web application requires at least six servers, two at each tier. Using virtualization technologies to flatten the architecture, a minimum of only two servers is needed: two servers for availability, with each server hosting Web, application, and database server software each in its own secure, virtualized environment. Network traffic can be secured outside of the each container by allocating a dedicated network interface to each environment, or by sharing interfaces and implementing separation through VLANs.

IT organizations can flatten layers in a number of contexts where related applications require multiple tiers today. For example, a Web application firewall and a Web server can be deployed in separate environments on the same server. A mail server, virus scanner, and

spam filtering suite can be installed into separate environments so that if an intruder is successful in breaking one component's security, they no longer have access to all three.

Development, Staging, and Production
With virtualization and partitioning technologies, IT organizations can deploy development, test, staging, and production versions of an application onto the same server. Each developer can work in their own personal environment. Once an application has been tested and readied for deployment, it can be installed into a virtualized environment for staging. When the new application is deployed, it's a matter of changing IP address and resource allocation — and the staging environment becomes the production one. Using this approach reduces the number of resources that an IT organization must support, and it provides an automatic fallback mechanism in the event that a new version must be rolled back to the previous one.

Legacy Application Consolidation
Sometimes a set of applications running on multiple operating system versions need a performance boost that can be accomplished by re-hosting onto a faster server. Or they run on no-longer-supported server or operating system versions. Using virtual machine technology, these applications can be consolidated onto high-performance x64 servers and receive the needed platform upgrade and performance boost. Host each operating system and application instance in its own separate virtual machine, assign an x64 processor to each VM, and watch performance soar.

Geographic Replication, Disaster Recovery
Deploying applications into containers or virtual machines makes it easy to package and re-deploy them anywhere around the globe for both geographic replication and disaster recovery purposes. Both Solaris Containers and VMware Virtual Infrastructure facilitate backing up and restoring virtual environments. In both cases, two sets of data are stored: the configuration settings for the container or virtual machine environment, and an archive of the environment's data itself. Given the same version of the Solaris 10 OS or VMware ESX Server on another system in another data center, it's straightforward to re-constitute a previously-saved environment.

Shared Hosting Environments
Internet Service Providers can offer customers their own complete Web hosting environment, giving them control over Web server software and even administrator passwords. Using Solaris Containers or VMware Virtual Infrastructure, ISPs can offer dedicated hosting with the efficiency of a shared hosting infrastructure.

Customers have access to consolidation and virtualization technology on Sun's newest platforms first through the Solaris Operating System.

Consolidation Guidelines

At a high level, the choices for an IT organization wishing to consolidate multiple applications onto a single powerful Sun x64 server are straightforward (Table 2):

- To consolidate multiple applications running on the Solaris 10 OS, use Solaris Containers.
- To consolidate a mix of applications running on the Solaris 10 OS, Linux or Microsoft Windows, use VMware Virtual Infrastructure.

At a deeper level, consolidation offers IT organizations the opportunity to simplify their environment by reducing the number of hardware and operating system platforms and versions they support.

Migrating While Consolidating
IT organizations can cut cost and complexity by migrating applications to a smaller number of platforms, giving them greater choice when consolidating. Consider:

- Migrating Linux applications to the Solaris 10 OS allows IT organizations to consolidate applications running on both systems into Solaris Containers environments. Many open source applications that run on Linux also come packaged with the Solaris Operating System. These applications can be used out-of-the-box in one or more Solaris Containers. Linux applications that are not already packaged with the Solaris OS can be re-compiled using the Linux libraries that are included with the Solaris 10 OS.
- Many server functions supported in Microsoft Windows have open source and commercial alternatives that run on the Linux and Solaris Operating Systems. Through migration, IT organizations can reduce the number of platforms and help to reduce licensing costs. For example, Microsoft Exchange Server functions can be supported with open source sendmail, open source calendaring packages, and also with Sun Java Enterprise System software. Web applications running on Microsoft Internet Information Service (IIS) can be ported to run on open source Apache or Sun Java System Web Server. Those that use Active Server Pages in Microsoft IIS can take advantage of Sun Java™ System Active Server Pages. (Currently, not all Sun Java Enterprise System products can be installed in Solaris Containers.)

Consolidating using Solaris Containers
For IT organizations wishing to consolidate multiple applications running on the Solaris 10 OS, multiple open-source applications, Linux applications ported to the Solaris OS, or any

combination of the above, Solaris Containers is the consolidation technology of choice.

IT organizations consolidating using Solaris Containers accrue all of the benefits of using the Solaris Operating System. Solaris Containers are a low-overhead partitioning approach, and the technology is included with the Solaris 10 OS at no extra cost. With feature parity across platforms, Solaris Containers can be used on Sun servers regardless of the underlying processor architecture.

Consolidating using VMware Virtual Infrastructure

When an IT organization wishes to consolidate a number of Solaris 10, Linux, or Microsoft Windows applications, or a mixed set of operating systems, VMware Virtual Infrastructure is the consolidation option of choice. Not only can its virtual machine technology support all three operating systems, it also can support multiple versions of Linux and Microsoft Windows.

IT organizations consolidating onto Sun x64 servers running VMware Virtual Infrastructure enjoy the additional benefit of migration software that helps to package up an entire environment so that it can be installed in its own virtual machine. The Sun BluePrints™ article *Consolidating Microsoft Windows NT applications onto Sun x64 Servers using VMware ESX Server* includes instructions for using VMware P2V (Physical-to-Virtual) software to perform just such a migration.

Sun — the Ideal Consolidation Partner

For IT organizations attempting a nearly-impossible juggle of competing priorities, consolidating multiple applications onto a smaller number of more powerful servers is one that helps to reduce capital and operational costs, increase utilization, increase availability levels, and provide for continued operation through geographic replication.

When IT organizations look for the right platform to support their operations, there is no better partner than Sun. With a long history of pushing mainframe-quality features down the product line to its mid-range and entry-level servers, Solaris Containers is only one of many technologies that Sun can share with all of its customers, regardless of how many or how large of a server they purchase. And because Sun develops new versions of the Solaris OS at the same time it develops new industry-leading server platforms, customers have early access to the newest server technology when they choose the Solaris OS.

When it comes to platform choice, Sun Fire X4100, X4200, V40z, X4600 servers, and the Sun Blade 8000 modular system offer the power of single- and dual-core processors with flexibility and investment protection. IT organizations wishing to deploy a dedicated operating system can choose between Solaris, Linux, and Microsoft Windows today, and re-deploy the same server with a different operating choice the moment their needs change. Those wishing to consolidate multiple applications running on multiple operating systems have the flexibility to run them unchanged in virtual machine environments or migrate open source and Solaris applications into Solaris Containers. Whichever choice an IT organization makes for consolidation through virtualization, the best choice is using Sun x64 servers.

Learn More

To learn more about Sun x64 servers, please visit *sun.com/x64*.

To learn more about Solaris Containers, visit *sun.com/solaris*. To download your own copy of the Solaris 10 OS, visit *sun.com/software/solaris/get.jsp*.

To learn more about VMware Virtual Infrastructure, visit *www.vmware.com*. To download a trial copy of the software, visit *www.vmware.com/download*.

To learn how to put consolidation through virtualization to work for you, contact your Sun sales representative, or call 1-800-555-9SUN.

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