

# Server Virtualization

Choosing the best solution for your business

Server virtualization delivers many business benefits to datacenters today. Virtualization technology can help you quickly recover from disasters, reduce time to market for new services, and better utilize existing infrastructure to reduce space, power, and cooling requirements. It can help increase service levels while delivering security that once required the use of individual servers. Choosing the right server virtualization product is an important business decision, and Sun has the virtualization and server technology portfolio — along with the experience — to help you make the right one.

comprehensive range of virtualization choices for all Sun servers.

Solaris™ Containers combine resource management and virtualization in the Solaris Operating System for a no-cost solution that works on every server running the Solaris OS. On UltraSPARC® servers based on CoolThreads™ technology, Logical Domains partition hardware resources, including individual CPU threads, for greater isolation between OS instances, each of which can be configured with Solaris Containers.

## Highlights

- Every IT organization has a unique set of requirements driving the choice of virtualization technology, and choosing the right technology means carefully assessing both business and technical requirements
- Sun has years of experience delivering virtualization technology and offers an extraordinarily flexible range of choices to meet a wide range of requirements
- Sun supports server virtualization through-out its server product line, including energy-efficient servers with CoolThreads technology, Sun x64 servers, and servers built with the latest UltraSPARC and SPARC64® processor technology
- Sun can help you increase server utilization and power and cooling efficiency with virtualization solutions that can be deployed on all your servers

## Choosing the best virtualization technology for the job depends on understanding the interplay between business and technical requirements.

### Offering choice and flexibility

Sun offers choice and flexibility when it comes to server virtualization technology. You can choose from among the most innovative server virtualization technologies available anywhere and then run them on energy-efficient Sun servers. Best of all, Sun gives you the flexibility to choose the right solutions for your environment, your technical and business requirements, and your budget.

### Sun's comprehensive portfolio

Sun has been building its server virtualization technology portfolio since 1997, when Dynamic Domains enabled hardware partitioning on Sun's high-end servers. Since then, Sun has focused on creating products that deliver a

Sun xVM server software runs the Solaris, Linux, and Microsoft Windows operating systems on x64 servers from Sun and other companies, giving you a multivendor solution that can be used datacenter-wide, with Sun xVM Ops Center providing an integrated management solution.

Sun supports virtualization on x86-architecture servers with AMD Opteron™ and Intel® Xeon® processor-powered Sun Fire™ x64 servers and blades. These systems support both VMware Infrastructure and Microsoft Virtual Server. Sun now provides support for VMware software running on Sun x64 servers.

#### Helping you decide

The term *server virtualization* as used in this brief describes technology that helps effectively run multiple applications on the same server with the desired amount of isolation between them. And with years of experience and a rich portfolio of virtualization technology, Sun is ideally positioned to help you choose which server virtualization technologies can best serve your IT organization—based on your specific business and technical requirements.

#### Business drivers for virtualization technology choice

The choice to adopt virtualization technology must be driven primarily by its business benefits, and understanding your requirements is a key step in determining which virtualization technologies are most appropriate for your organization.

Although consolidation is often the primary reason to deploy server virtualization technology, solutions from Sun can be used to address a much broader range of business issues. Virtualization provides solutions to some of the difficult business issues that IT organizations face today:

- **Is managing and administering your environment getting increasingly complex and more costly as you add servers?** Virtualization can help you to make server and service deployments independently. This helps your server infrastructure become a shared pool of resources that can be harnessed as needed in response to rapidly changing business requirements.

- **Is a lack of scalability limiting your business?** With server virtualization, you can scale up by increasing the resources allocated to your application and scale out by adding more instances of them.

- **Do you need reliability on par with mainframe systems?** You can run your applications in Dynamic Domains on supported Sun SPARC® Enterprise servers and enjoy the reliability, availability, and serviceability of Sun's most powerful servers.

- **Are your clients pressuring you to deploy more servers than you can manage?** With virtualization, you can deploy a smaller number of more powerful servers, each running a number of different environments. Many of Sun's servers offer excellent scalability by allowing more memory, processors, and I/O devices as business needs demand.

- **Can you meet incremental demands on your IT infrastructure without increasing budget?** Many fast-moving IT organizations are tasked with deploying a constant stream of applications and letting the market choose which ones are viable. Virtualization technologies help you develop, test, and deploy new applications on the same servers as production environments by allocating small amounts of resources to them initially, then scaling as application workloads increase.

- **Do you have a strategy in place for availability and disaster recovery?** Virtualization technology can make it straightforward to replicate and run multiple instances of an environment

for increased application availability without as much backup hardware needed. When these environments are replicated remotely, they're ready to start on a moment's notice in the event of a disaster at the primary site.

- **Do you guarantee quality-of-service levels, and are you able to meet your agreements?** Managing your server infrastructure as a single, flexible pool of virtualized resources allows you to adjust the relationship between services and servers as needed to help maintain service levels.

#### Technical drivers for virtualization technology choice

While the choice to deploy virtualization technology is primarily a business one, answers to technical questions such as the following can help narrow the range of choices:

- **What standard operating systems do you use?** Operating systems sometimes dictate underlying processor architectures and the virtualization technology that you use. For example, the Solaris OS runs on both SPARC and x64 processor-powered servers, while Microsoft Windows requires x86/x64 systems.
- **What level of security isolation do you require?** Different layers in a multitier Web application need to be isolated in order to secure business-critical data in a back-end database. Some organizations need security isolation in order to comply with governmental and business regulations. Others may need isolation to keep different client organizations or customers from interfering with each other's applications—whether intentionally or accidentally.

- **What level of fault isolation do you need?** Virtualization can help limit the propagation of hardware, operating system, and application faults to varying degrees depending on your requirements.
- **What are your performance requirements?** Some organizations use virtualization to run legacy environments on new hardware without concern for the performance overhead. Others need to maximize performance, and choosing a virtualization technology with the least overhead is important.

### Producing quantifiable results

The answers to these business and technical questions can help guide your choice of virtualization technology. And once your virtualization technology is implemented, consider how to measure whether you have met your goals by measuring the impact on areas that are important to your organization:

- Calculate savings in software and OS licensing, as well as support costs
- Measure savings in power, cooling, and space consumption
- Evaluate overall increases in server utilization
- Monitor reductions in planned and unplanned downtime
- Verify reduced application deployment time
- Test and evaluate whether you have met disaster-recovery goals

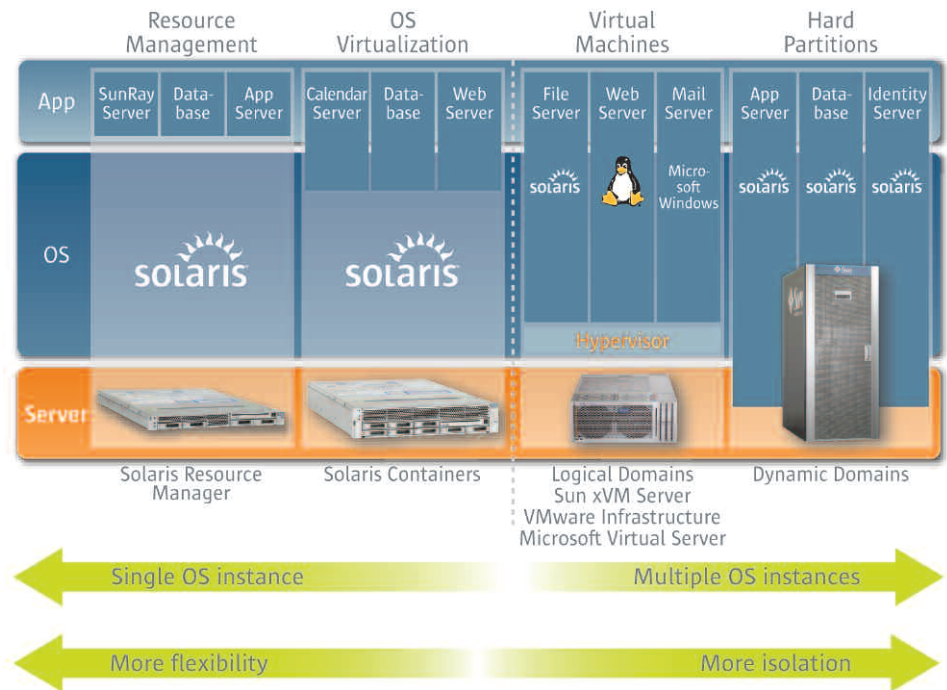


Figure 1: Sun offers a range of virtualization technologies, from simple resource management to full electrical isolation between multiple operating system instances.

### A range of solutions to meet a range of business and technical requirements

Virtualization technologies available from Sun include those that support a single operating system instance or multiple OS instances; solutions that provide little isolation and those that provide complete isolation; and solutions that range in the degree of flexibility and performance they offer. Figure 1 illustrates four categories of server virtualization technologies offered by Sun ordered by the degree to which they offer isolation between applications.

- **Resource management** enhances the benefits and simplicity of running multiple applications on the same server and OS instance. Applications supported this way coexist on the same server and are

isolated only to the degree that OS-level security and resource management features keep them (and their administrators) from interfering with each other.

- **OS-level virtualization** provides more isolation than simple resource management by allowing multiple applications to share the same operating system instance while providing separate security domains for each application. With Solaris Containers, customers can migrate existing Solaris 8 and Solaris 9 environments to Sun's current hardware, including Sun SPARC Enterprise M Series servers, without having to migrate or change existing applications.

- **Virtual machine monitors** provide greater isolation by supporting multiple OS instances on the same machine. Each application can run in its own OS instance, and a hypervisor gives each one the illusion that it “owns” a complete, dedicated set of hardware. With products available for Sun x64 servers, virtual machines can support multiple types of operating systems. And resource management and OS-level virtualization can also be used within each environment running the Solaris OS.
- **Hard partitions** support multiple operating system instances without the overhead of a hypervisor. Available on Sun’s high-end servers, including Sun SPARC Enterprise M Series servers, Dynamic Domains provide the ultimate in isolation with a separate electrically isolated environment for each OS.

### Choosing the right virtualization technology for the job

The process of choosing the right virtualization technology to meet business and technical requirements can sometimes be straightforward. For example, if you need to host multiple applications, each in its own OS instance, on a highly scalable server with some of the best RAS characteristics available anywhere, hard partitioning through Dynamic Domains is a good match for your requirements.

However, in most cases the choice isn’t as obvious. One approach for narrowing down the options is to compare business and technical requirements to each of the solutions that Sun offers. In Figure 1, you’ll notice that some of Sun’s technologies provide a better match than others.

And in many cases, more than one of Sun’s solutions will provide a match, giving you even greater freedom to choose.

### Resource management

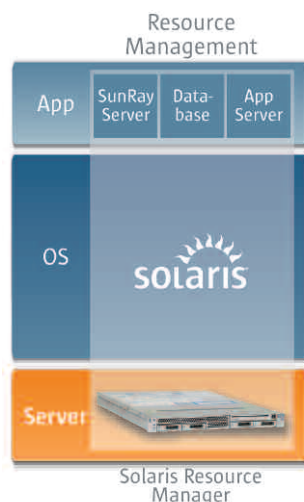
Since the 1960s, timesharing systems have provided one of the most straightforward ways to run multiple applications on the same server. The security and fine-grained resource controls provided by the Solaris OS further increase the effectiveness of this very simple and flexible approach to running multiple applications on the same machine.

Solaris Resource Manager software (Figure 2) gives administrators almost unlimited flexibility to assign and isolate resources to specific applications. Mechanisms such as processor sets allow physical resources to be dedicated

to specific applications. Scheduling mechanisms such as the Fair Share Scheduler support dynamic resource allocation, which enables proportions of resources—such as fractions of a CPU—to be allocated to various applications. When dynamic resource allocation is used, resource-capping controls can set limits on the amount of resources consumed by any one application. Finally, Solaris IP Quality-of-Service can be used to manage network bandwidth.

Security isolation between applications is usually important, and with role-based access control (RBAC), the Solaris OS gives more fine-grained control over security than simply having different users “own” the various applications. Administrators can set up specific roles that allow different users authority over different applications, limiting the scope of changes those users can make. This helps prevent one application administrator from inadvertently interfering with applications they are not authorized to manage.

However, the very simple approach of running multiple applications in a single OS instance has its limitations. Because resource management alone does not provide a virtualized, independent environment for each application, the same operating system namespace, file systems, security, and fault domains are shared among all applications on the system. Many of these limitations are lifted with OS virtualization, virtual machines, and hard partitions, which are discussed in the following sections.



*Figure 2: The simplest solution for supporting multiple applications on the same server is to run them on the same OS with fine-grained resource controls managing resource allocation.*



### Server and OS support for resource management

Although multiple applications can run on most operating systems, the fine-grained resource control discussed in this section is available with the Solaris Operating System. This approach can be used on any platform running the Solaris OS, including SPARC and UltraSPARC processor-powered servers, and Sun x64 servers.

### Operating system virtualization

Solaris Containers go beyond simple resource management by integrating it with operating system partitioning. Solaris Containers technology is a no-cost option from Sun that combines Solaris Zones and Solaris Resource Manager (Figure 3).

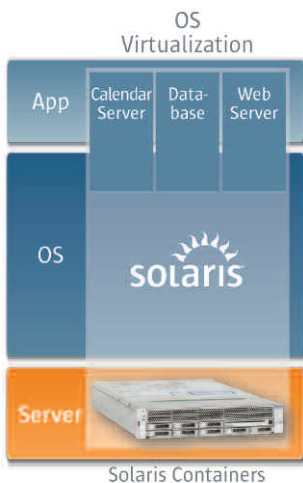


Figure 3: Solaris Containers support multiple applications on the same OS instance, with each container providing a unique security and fault domain.

What Solaris Zones add to the picture is the ability for each application to have its own security and fault domain, name-space, locale, file-system, storage, and network resources. This allows multiple applications to have what appears to be their own operating system instances, with resources such as CPU and memory allocated to them according to policies set with Solaris Resource Manager.

Different application administrators can be given root access to the containers they “own” without the risk of those administrators intentionally or accidentally escalating their privileges and affecting applications running in other containers. Fault isolation restricts the propagation of software faults to a single container. If an error causes a container to fail, it can reboot in only a few seconds because the underlying single operating system instance runs intact.

### Branded zones

A branded zone (BrandZ) is a special type of container that can provide the illusion that it's running a different operating system than the one controlling the hardware. Today, branded zones can be configured to support applications running on Red Hat Linux, Solaris 8 and 9 Operating Systems, and Solaris Trusted Extensions.

### Efficient use of resources

The key benefit of Solaris Containers is efficiency. The overhead of running applications is nearly zero, as compared to virtual machine monitors that must trap every privileged instruction in order to create the illusion of each operating system instance running on dedicated hardware.

Unlike virtual machines, the use of a single OS instance to support multiple containers means that less memory is required: using Solaris Containers and sparse-root container configurations, all operating system modules and commands share the same pool of memory, so even if multiple instances of a command are running, they all share the same executable code.

Solaris Containers are a preferred solution when multiple Solaris 8, 9, and 10 OS and Linux applications can share the same OS instance. When more isolation between OS instances is required, or when running a mix of operating systems that includes Microsoft Windows, consider virtual machines. If hardware fault isolation is required, along with OS isolation, consider using Dynamic Domains.

### Server and OS support for Solaris Containers

Solaris Containers run on any platform running the Solaris 10 Operating System, whether SPARC, UltraSPARC, or x64 servers. The beauty of Solaris Containers is that they can be used in a standalone instance of the Solaris OS or in conjunction with any of the other virtualization technologies discussed in this brief. Solaris Containers can be used in a Solaris OS instance running in a virtual machine or a Dynamic Domain. Solaris Resource Manager can be used to enforce fair sharing of resources across containers, and it also can be used to manage the resources within a container.

### Virtual machine monitors

Virtual machine monitors (VMMs) comprise a class of technology that allows multiple heterogeneous OS instances to run on the same server, each of which has the illusion of running on dedicated hardware (Figure 4). Sometimes called a hypervisor, a VMM supports a virtual machine for each guest OS instance.

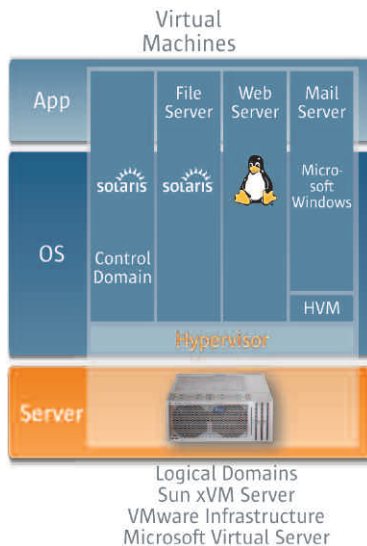


Figure 4: Virtual machine monitors support a heterogeneous mix of operating systems on the same hardware platform.

Virtual machine monitors allow you to:

- Host multiple heterogeneous operating systems on a single platform
- Easily provision new services using only a slice of existing server capabilities
- Rapidly deploy new virtual machines on any server to meet rapidly changing business requirements

- Increase utilization, helping to reduce capital and operating costs
- Load balance virtual machines across server farms

Virtual machine monitors provide a degree of isolation beyond Solaris Containers technology: an individual OS can fail completely, or be compromised from a security standpoint, and it cannot affect other OS instances running under the same VMM. For example, if you want to run multiple operating systems other than the Solaris OS, or want to run or test different patch levels of the Solaris OS, VMMs are one solution. As a class, VMMs support the widest set of operating systems, and they can run on servers with one or many CPUs.

Sun offers a choice of three VMMs: Sun xVM Server, Logical Domains, and VMware Infrastructure. Additionally, Sun xVM VirtualBox™ software supports virtualization on the desktop for developers. Microsoft Virtual Server is a virtual machine monitor that also runs on Sun x64 servers.

### Sun xVM Server

Sun xVM Server uses the Solaris OS as a control domain and runs on Sun x64 servers. It supports virtual machines running the Solaris 10 OS, Linux, and Microsoft Windows.

Sun xVM Server uses a highly efficient technique called paravirtualization to avoid the overhead of requiring the VMM to emulate or rewrite instructions any time a guest operating system performs a privileged operation.

In a paravirtualized environment, the host operating system is aware that it is running on top of a hypervisor, and it cooperates by making function calls to the hypervisor any time it wishes to perform I/O. For example, all I/O passes from the guest OS to the control domain, which actually handles I/O operations on behalf of the guest.

This reduces the amount of work that the VMM needs to do in order to support each virtual machine, freeing more CPU cycles to help deliver greater application performance. In the case of Sun xVM Server, the Solaris 10 OS and some versions of Linux are paravirtualized. When running Microsoft Windows operating systems, a hardware virtualizer provides a fully virtualized environment to the OS.

### Server and OS support for Sun xVM Server

Sun xVM Server runs on Sun x64 servers, with supported guest operating systems that include the Solaris 10, Linux, and Microsoft Windows operating systems.

### Sun Logical Domains

Sun Logical Domains is a no-cost virtualization technology that runs on CoolThreads technology-powered servers. Logical Domains are similar to Sun xVM Server in two respects: guest operating systems are paravirtualized and perform I/O through virtual devices supported by one or more I/O domains. But unlike VMMs, Logical Domains partition hardware resources—down to the level of processor threads, on-chip cryptographic accelerators, and memory—rather than sharing them across domains using scheduling and paging mechanisms.

### Sun Logical Domains combine virtual machine technology with sub-CPU partitioning to deliver even greater isolation between domains.

The result is a greater level of isolation than typical VMMs can provide, and greater efficiency. Because each CPU thread is associated with a specific Logical Domain, processor cache performance should be greater than in systems where any virtual machine may run on any processor thread.

On systems with multiple PCI buses, each bus may be owned by a different I/O domain, allowing domains to have multiple redundant I/O paths for high availability.

#### Server and OS support for Logical Domains

Logical Domains are supported by the Solaris 10 Operating System. Guest domains can run any version of the Solaris 10 OS beginning with Solaris 10 11/06. Logical Domains are supported on Sun servers with CoolThreads technology, such as the Sun Fire T5120 and Sun Fire T5240 servers.

#### Sun xVM Ops Center

xVM Ops Center is a comprehensive management tool to manage Sun servers and virtualization products— xVM server, Containers and LDom. xVM Ops Center is a highly scalable data center automation platform that simplifies lifecycle management of virtual and physical systems across Solaris, Windows, Red Hat and SUSE OS-based environments.

#### VMware Infrastructure

VMware Infrastructure, comprised of VMware ESX Server and VirtualCenter, its management platform, is a traditional virtual machine monitor that provides full virtualization. This allows the software to provide each guest operating system with a faithful representation of an underlying set of hardware, down to the processor and peripherals— regardless of the actual underlying processor.

VMware ESX Server's full virtualization makes it easy to move virtual machines from server to server without worrying about the processor architecture. It also means that, by emulating hardware that is now obsolete, you can capture images of servers running old OS versions (such as Microsoft Windows NT) and run them under VMware ESX Server. This gives old applications a performance boost and puts them on reliable, up-to-date systems.

Because it provides full virtualization, the underlying OS is unaware that it's running in a virtual machine. This allows VMware ESX Server to support a broad set of guest operating systems, including the Solaris 10 OS and multiple versions of Red Hat Linux, SUSE Linux, FreeBSD, Novell Netware, and Microsoft Windows operating systems.

Full virtualization is a trade-off between performance and flexibility. The ability to run such a broad set of guest operating systems comes from the VMM's ability to emulate the appropriate processors and peripherals for each guest OS. This requires trapping privileged instructions and rewriting instruction sequences so they execute exactly as they would on the emulated processors.

#### The limits of virtual machine monitors

By encapsulating each guest OS in its own individual virtual machine, VMMs offer excellent security and fault containment while providing the underlying technology to treat your server infrastructure as a uniform, flexible pool of resources that can be harnessed at a moment's notice to meet rapidly changing business needs.

But some business-critical applications such as databases and enterprise resource planning software need to run on highly available servers that can scale up or down without even taking applications offline. For these situations, Dynamic Domains is the answer.

### Hardware partitioning with Dynamic Domains

Dynamic Domains is a no-cost virtualization technology that's the solution for environments in which the ultimate in reliability, availability, and serviceability is required. Dynamic Domains are available on Sun SPARC Enterprise M Series servers (Figure 5).



Figure 5: Dynamic Domains provide complete electrical isolation between domains, allowing multiple applications to enjoy the scalability, performance, and RAS features of Sun's high-end servers.

Dynamic Domains partition server resources such as CPU, memory, and I/O devices into multiple domains that are physically and electrically isolated. The isolation is so complete that one domain can be taken down and physically reconfigured or maintained without affecting domains running on the same server.

Dynamic Domains allow server hardware to be scaled, configured, and replaced without bringing domains down, and in most cases the Solaris OS adjusts automatically to changes in available resources. This allows business-critical software to keep running despite events that would take nearly any other server down completely.

Just as all of the virtualization techniques described to this point allow resources to be allocated in varying amounts to individual guest operating systems, containers, or applications, Dynamic Domains allow resources to be moved dynamically between domains on the same server. Resources assigned to Dynamic Domains can be increased or decreased on a manual, ad hoc basis, or on an automatic, scheduled basis.

Consider a Sun server with one Dynamic Domain hosting the company's OLTP database, and another domain hosting the company's data warehouse. During the business day, while the company is taking orders for products, the OLTP database is a business-critical application. At night, the marketing organization performs long-running queries against the data warehouse.

Using Dynamic Domains, the OLTP system can be allocated the majority of server resources, while at night the data warehouse can receive the majority of resources, all of them adjusted automatically and without forcing domains to reboot in order to adjust to the changing level of resources.

## Sun Server Virtualization Product Compatibility

Available on the following Sun Servers					Supports the following operating systems		
Virtualization Technology	High-End SPARC® Servers	SPARC Servers	CoolThreads™ Technology Servers	Sun® x64 Servers	Solaris OS	Linux	Microsoft Windows
Solaris Resource Manager	✓	✓	✓	✓	✓		
Solaris Containers	✓	✓	✓	✓	✓	✓	
Logical Domains			✓		✓		
Sun xVM Server				✓	✓	✓	✓
VMware Infrastructure				✓	✓	✓	✓
Dynamic Domains	✓				✓		



#### Server and OS Support for Dynamic Domains

Dynamic Domains are available on Sun's high-end servers, including the Sun SPARC Enterprise M Series servers, and Sun Fire E20K and E25K servers. Dynamic Domains support the Solaris OS within each domain.

#### The right choice—Sun

Across the spectrum of server virtualization technologies from Sun are products that support homogeneous environments and some that support heterogeneous ones. There are products that offer virtualization choices for single-processor servers and those that can scale up to 144 processors on Sun's largest servers.

There are products that offer the enhanced security of isolated domains that are created out of individual CPU threads and those that put the power of multicore SPARC processors to work for your applications. Figure 5 summarizes the range of options from Sun and its partners along with the platforms and operating systems they support.

Choosing a virtualization strategy isn't as simple as picking a favorite. To get the greatest business benefit from virtualization requires assessing the range of technologies and making a choice that meets both your business and technical requirements.

Sun offers an extraordinarily flexible range of virtualization choices and an equally extra-ordinary server product line to support them, from those with the most energy-efficient processors available anywhere to those with the raw processing power to handle the most demanding enterprise applications.

#### Starting your journey

Choosing Sun puts an experienced team at your service to help determine the right virtualization technology for your business. Sun delivers the services you need to plan, design, implement, and deploy server virtualization technology.

Sun's Virtualization Workshop, Virtualization Architecture, and Virtualization Implementation service offerings support your virtualization project so that you can better focus on maintaining your competitive edge.



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