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Virtualization with Oracle Solaris 10

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Introduction

Nearly every aspect of a business depends on the applications and services provided by corporate datacenters to stay ahead of changing business conditions. As users demand greater functionality, applications are becoming increasingly sophisticated. These changes are in turn placing burdens on the underlying computing infrastructure. To compensate, organizations spend a significant portion of the IT budget on capacity expansion to build on existing infrastructure and meet service-level agreements. Over time, the influx of servers results in a sprawling, complex network of systems that consume valuable datacenter floor space, create excessive power and cooling demands, and are costly and difficult to manage.

Virtualization Strategies Can Help

Today virtualization techniques are taking center stage in the battle to reshape the datacenter and reduce operating expenses. Providing the ability to get more work done using fewer resources, virtualization is fast becoming a necessity. Indeed, companies are employing virtualization techniques to consolidate applications and data onto fewer servers, gain the ability to move workloads to systems with available resources on an as-needed basis, support legacy applications on newer systems, provision systems faster, and overcome scalability constraints. Now storage and desktop virtualization mechanisms are taking virtualization to a new level, helping to optimize the entire datacenter infrastructure.

While made possible by hardware platform advances that deliver significant capacity and performance improvements every twelve to eighteen months, virtualization has its challenges. The ability to capitalize on Moore's Law and take advantage of greater processor and thread density in systems lets more virtual environments be placed on a server—and each one must be maintained. In addition, virtualization density can increase application licensing costs and introduce performance overhead and security challenges if not done well. An integrated virtualization strategy that uses the right technology in the right place is needed to optimize the datacenter and gain greater efficiency and improved flexibility at less cost.

Comprehensive Desktop to Datacenter Virtualization Solutions

Oracle offers the most complete portfolio of end-to-end virtualization solutions available today. With full stack management from applications to disk, Oracle solutions can help companies consolidate systems, gain greater efficiency, rapidly deploy solutions, and more. Each virtualization technology comes with its own set of advantages—making it important to understand when and how they can best be deployed. Providing varying degrees of flexibility, availability, and security, these technologies can be used separately or together to affect better resource utilization and reduce infrastructure complexity. Solutions are available at every layer of the infrastructure—from operating system and resource virtualization, to virtual machines and hard partitioning, to desktops and storage.



Figure 1. Oracle's virtualization technology portfolio

Server Virtualization

Today many companies consolidate servers—bringing together applications, databases, and services onto fewer, highly reliable servers—to affect better resource utilization. But problems remain. Poor application behavior, system malfunctions, and security breaches can starve applications of compute resources and let a runaway program or malicious intruder affect many users. Fortunately, server virtualization technologies enhance consolidation strategies by helping organizations to create administrative and resource boundaries between applications on a system to deliver on application performance and security requirements. Oracle offers several server virtualization technologies that can be used separately or together to tackle specific deployment challenges.

Oracle Solaris Containers

An integral part of the Oracle Solaris 10 operating system, Oracle Solaris Containers provision many secure, isolated runtime environments for individual applications using flexible, software-defined boundaries. All containers run under a single operating system kernel, enabling fine-grained control over rights and resources within a consolidated server without increasing the number of operating system instances to manage. Oracle Solaris 8 and Oracle Solaris 9 applications and their environments can run in containers on Oracle Solaris 10, giving organizations access to the latest hardware and operating system advancements without impacting investments in applications. In addition, applications can be managed independently of each other. Companies can place one application in each virtual server to maintain isolation, if desired, while simultaneously sharing hardware resources.

With the ability to consolidate dynamic applications onto significantly fewer high-performance systems, Oracle Solaris Containers deliver strong performance improvements across a significantly reduced hardware footprint. By placing existing applications in containers on the latest hardware and operating system platform, deployments no longer need to be locked out of the developments made possible by Moore's Law. Applications that must communicate with one another to get a job done can be moved closer to one another to take advantage of intra-server scalability and eliminate the latencies introduced by physical server-to-server network interaction.

Deploying applications in Oracle Solaris Containers can help improve security and reduce licensing costs. The sophisticated network-wide security system in the operating system controls the way users access files, protect system databases, and use resources. Security needs are addressed at every layer, from integrated security services and applications, to enhanced encryption algorithms, to an enterprise firewall for network protection. Extended security features are also available, including authentication, data integrity, data privacy, and single sign-on capabilities so that tampering, snooping, and eavesdropping do not compromise data or transactions. Systems also can be hardened and minimized as needed, helping to reduce the risk that a system or application can be compromised. And unlike server virtualization solutions from other vendors that charge per processor core, Oracle Solaris Containers are included as part of Oracle Solaris, at no additional cost.

Managing physical and virtual server environments can be complex and time-consuming. Designed to handle the entire deployment lifecycle, Oracle Enterprise Manager Ops Center is a single platform that helps to bring complexity under control by managing multiple server architectures, and multiple operating systems running on bare hardware or in virtualized environments. It even manages virtualization itself, with the ability to manage Oracle chip multithreading servers employing Oracle VM Server for SPARC, or Oracle Solaris Containers running on any instance of Oracle Solaris on any server architecture. This open, extensible system can operate at massive scale, automate workflow, enforce compliance through policy-based management, and manage heterogeneous environments with virtualized and non-virtualized systems, all through a single intuitive interface.

Oracle VM

Oracle VM is a family of products that work together to facilitate virtual environment creation and management. Consisting of Oracle VM Server and the integrated Oracle VM Manager browser-based management console, Oracle VM makes it easy to create and manage virtual server pools running on systems across the enterprise. Organizations can create multiple virtual machines on a physical x86, x64, or SPARC® processor-based server, yet have each environment behave independently—with its own virtual CPUs, network interfaces, storage, and operating system.

- **Oracle VM Server for x86.** Free to download, Oracle VM Server for x86 provides an easy-to-use graphical interface for creating and managing virtual server pools running on x86 and x64 systems. This server virtualization software fully supports Oracle and non-Oracle applications, as well as Oracle Solaris, Linux, and Windows guests. Backed by Oracle's world-class support organization, Oracle VM Server for x86 provides customers with a single point of enterprise-class support for virtualization environments and delivers more efficient performance. A wide range of Oracle products—including Oracle Database, Fusion Middleware, Oracle applications, and Oracle Enterprise Linux—are certified with Oracle VM Server for x86.
- **Oracle VM Server for SPARC.** Purpose-built for Oracle servers with chip multithreading (CMT) technology, Oracle VM Server for SPARC (previously called Sun Logical Domains) provides a full virtual machine that runs an independent operating system instance and contains a wide range of virtualized devices. A hypervisor that largely resides in a chip on the server is tightly integrated with the hardware, enabling virtual machines to take advantage of underlying system advancements and reduce the overhead typically associated with software-based solutions. Unlike solutions from other vendors that do not permit add-on networking or cryptographic devices to be partitioned, shared, or abstracted, Oracle VM Server for SPARC supports virtualized CPU, memory, storage, I/O, console, and cryptographic devices, and redundant I/O paths, to make maximum use of platform resources.
- **Oracle VM Manager.** Oracle VM Manager provides an easy-to-use, feature-rich graphical interface for creating and managing Oracle VM environments. With Oracle VM Manager, administrators can enable advanced functionality to load balance across resource pools and automatically reduce or eliminate outages associated with server downtime.
- **Oracle Enterprise Manager.** Including Oracle VM Management Pack, Oracle Enterprise Manager provides a comprehensive management solution for managing virtual machines, and the operating systems and software inside them, from a single product. Oracle VM Management Pack provides integrated, in-depth health and performance monitoring, configuration management, and life cycle automation for virtual and physical infrastructure for maximum efficiency.
- **Oracle VM Templates.** Oracle VM Templates facilitate rapid software deployment by providing pre-installed and pre-configured software images. With these tools, companies can shorten time to market, eliminate installation and configuration costs, and reduce ongoing maintenance and operational costs. Templates are available for immediate download for many key Oracle products, including Oracle Database, Oracle Enterprise Linux, Oracle Fusion Middleware, and more.

Dynamic Domains

Available on Oracle's Sun SPARC Enterprise® M-Series servers, Dynamic Domains technology enables a single system to be divided into multiple electrically isolated partitions for the ultimate in workload isolation. Each domain runs its own instance of Oracle Solaris 10—even different versions of the operating system—on dedicated hardware. A high-performance system, network, and I/O architecture eliminates overhead and delivers bare-metal performance to applications. Hardware and software failures are contained within a domain, increasing availability and providing a reliable, secure platform for running multiple applications simultaneously. These hard partitions also support the physical insertion or removal of system boards from a running domain without stopping the server or operating system.

Desktop Virtualization

Workplace flexibility is an ally in the move to reduce expenses. However, giving users the ability to move from place to place without losing the functionality of traditional fixed asset environments poses a host of desktop management and security challenges. To help this effort, Oracle provides a set of client- and server-based desktop virtualization solutions that transcend the limitations of conventional desktop computing to deliver secure, anytime, anywhere access to IT resources from any device.

- **Oracle Virtual Desktop Infrastructure.** Companies can take advantage of this complete solution for managing, hosting, and providing access to virtualized desktop operating systems hosted in the datacenter. By standardizing on virtual desktop images that can be used across organizations, IT staff can reduce the overhead associated with managing individual desktop operating systems. Users can access the same desktop environment from many different client devices and locations, enabling disaster recovery, remote office and work from home, and green computing through the use of low-power thin-client devices such as Oracle's Sun Ray Clients.
- **Sun Ray Clients.** These simple, low-cost devices are ideal for displaying server-hosted virtual desktops. With no moving parts and no local operating system to manage, Sun Ray Clients provide a cost-effective, highly functional thin client alternative to desktop and laptop computers and reduce many of the problems associated with traditional desktop deployments.
- **Oracle Secure Global Desktop Software.** This software delivers secure access to centralized, server-hosted Windows, UNIX®, mainframe, and midrange applications from a variety of clients, including Windows PCs, Mac OS X systems, Oracle Solaris workstations, Linux PCs, thin clients, and more. Access to full-screen desktop environments is provided, letting administrators use a single solution to provide access to server-based applications and server-hosted desktop environments.
- **Oracle VM VirtualBox.** Supporting an extensive range of host and guest operating systems, the open-source Oracle VM VirtualBox solution lets client systems run multiple environments at the same time to get the most flexibility and utilization out of systems. It provides high-performance support for a large number of virtual appliances available in the Open Virtualization Format (OVF), multiplatform application development and testing, 2D and 3D graphics acceleration, as well as the ability to teleport a running virtual machine between hosts without interruption.

Storage Virtualization

As data volumes continue to rise, datacenter managers must cope with expanding storage infrastructure and provide around the clock access to data that is stored on reliable and secure media in order to support demand. In addition, stringent compliance regulations are forcing organizations to retain data for longer time frames. These issues are compounded by service level demands that require greater operational efficiency, and economic pressures that necessitate cost reductions.

Oracle's storage virtualization technologies can help organizations eliminate redundant data, reduce bandwidth requirements, gain flexibility, and better utilize existing infrastructure to reduce space, power, and cooling requirements. Oracle Sun Storage Virtualization offers a broad range of storage virtualization solutions, including integrated virtualization capabilities in Oracle Solaris 10, disk storage systems, virtual tape solutions, and services that can help companies achieve optimal performance.

- **An easier way to manage volumes and storage systems.** Unlike most operating systems that leave volume management to add-on tools, Oracle Solaris 10 integrates volume management functions. Breaking free of the typical one-to-one mapping between the file system and its associated volumes, Oracle Solaris ZFS decouples the file system from physical storage, allowing for more efficient use of storage devices. By automatically allocating space from a shared pool of storage resources when needed, Oracle Solaris ZFS simplifies storage management.
- **Network access to data.** Oracle Solaris 10 delivers open, scalable, general-purpose file sharing with support for the Network File System (NFS). Enabling the transparent sharing of data and programs between heterogeneous systems, NFS allows access to files without regard to their physical location.
- **Flexible, tiered data storage.** Balancing the value of information and the cost of storing it can be difficult. Oracle solutions can help datacenters store information so that it is available when needed—and at the cost and integrity level required. For example, companies can move data from fast online disk systems, to slower disks, tape libraries, or archival systems manually or automatically to fit business needs and cost constraints.
- **Uniform storage management interface.** Part of Oracle Database 10g and 11g, Oracle Automatic Storage Management provides a simple storage management interface that is consistent across all server and storage platforms for greater management flexibility and efficiency.

Putting Oracle Solaris 10 Virtualization Technologies to Work

A rich set of scalable and integrated technologies, Oracle's virtualization solutions are designed to help solve organizational challenges. By deploying these tools, companies of any size in any industry can tackle specific problem areas, streamline operations, and raise the availability and performance of systems, applications, and services.

Consolidate and Scale

With applications the focus in any organization, companies routinely upgrade business-critical software. However, the underlying platform infrastructure often remains unchanged and vastly underutilized. Opportunities exist to reduce inefficiency and consolidate business applications onto fewer systems that can handle a greater workload. For example, consider a company with several previous-generation servers, each running one enterprise application that minimally stresses the server and utilizes only 5% to 10% of resources. The applications and workloads from these four systems can be consolidated onto a single next-generation server running Oracle Solaris 10. Oracle Solaris Containers can be used to create virtual environments, each running one enterprise application (Figure 2). On the new system, significantly less utilization is needed to handle the four applications. By consolidating from several older systems onto a newer, high-performance system and employing virtualization techniques, the company can better utilize compute resources while maintaining headroom for growth and lowering energy and support costs.

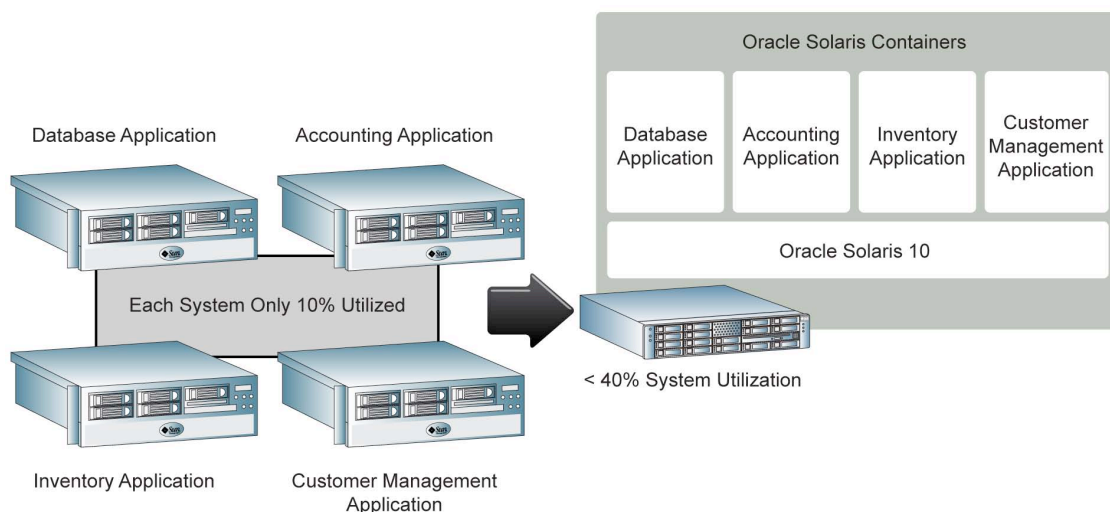


Figure 2. Consolidation and virtualization techniques work together to increase system utilization rates

Proof That Consolidation Works

Recently Oracle consolidated two of its campuses into new, next-generation datacenters supporting the R&D business. By replacing older servers and storage systems with the latest technology, Oracle compressed 152 datacenter rooms occupying 202,000 square feet of space into 14 new, next-generation datacenters occupying 76,000 square feet. Over 2,100 servers and 700 storage devices were identified as candidates for replacement. In the end, Oracle was able to reclaim 88% of valuable datacenter floor space, reduce overall datacenter power consumption by 61%, improve server performance by 465%, improve storage capacity by 244%—and do it all with less than half the original hardware—saving over \$500,000 per year in utility costs alone.

Support Legacy Applications

Many companies have a large number of small legacy applications on multiple systems, each running a different operating system or patch level. Finding ways to protect investments made in these environments and applications is a key concern when consolidation and virtualization efforts are underway to reduce server footprint. Using Oracle Solaris Containers, companies can consolidate these environments onto a single server running Oracle Solaris 10. In this solution, the server is divided into distinct areas that each run an operating system in an isolated application execution environment at the same time on the same system (Figure 3).

Each container provides the functionality of previous-generation operating systems, as well as any application software, and can take advantage of the resources and services provided by the underlying hardware in order to complete tasks. As a result, the specific configuration needs of hosted applications can be addressed individually. In fact, different versions or patch levels of an operating system can be hosted on the system, giving each application access to the specific operating system features needed.

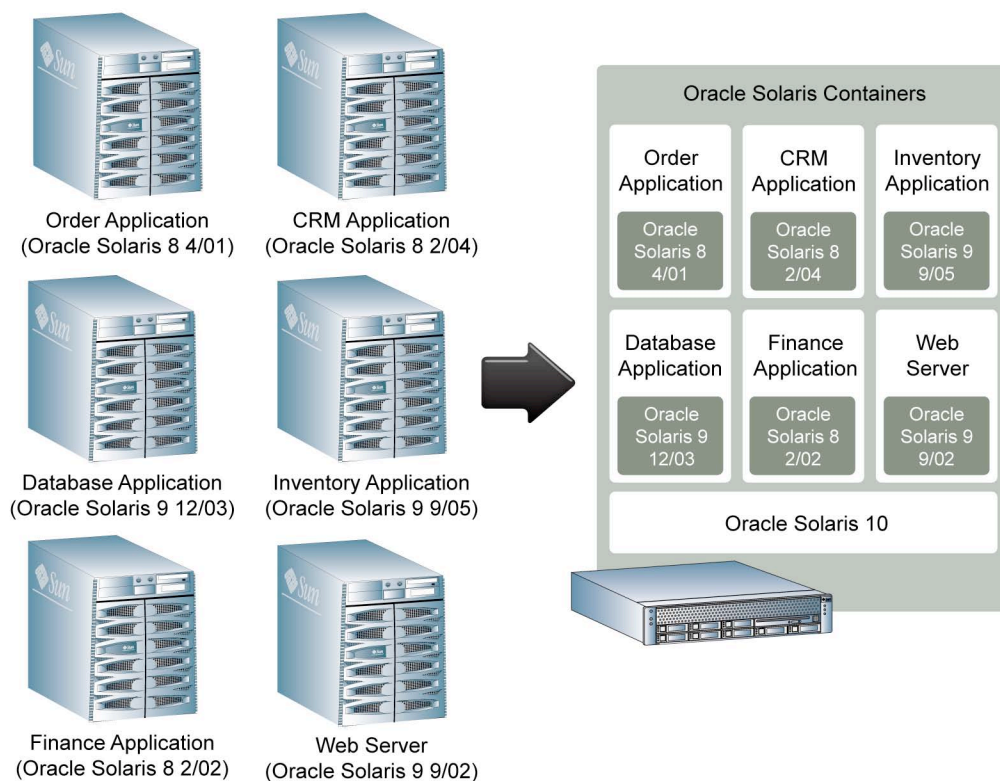


Figure 3. Oracle VM Server lets companies consolidate legacy applications onto a single server to raise resource utilization rates and lower operating expenses

By taking advantage of Oracle Solaris Containers, enterprises can increase flexibility and securely isolate applications while reaping the efficiencies of a consolidated platform. For example, consider an environment with six Sun Fire V880 servers, each running one application. Together these servers utilize 48 CPUs in 204 RU and require 13,200 Watts, 43,308 BTUs, and \$32,400 in operating system support costs. The applications and environments on these servers can be consolidated onto a single Sun SPARC Enterprise T5240 server with 2 CPUs running Oracle Solaris 10. The new system only requires 1,100 Watts, 3,608 BTUs, and \$2,968 in operating system support costs, and occupies only 2 RU. By consolidating onto this newer platform, a company can experience 92% space savings, utilize 92% less power and 92% less BTUs, and lower annual support costs by 91%.

Scale to Meet Demand

Many enterprises rely on applications and services that are designed to scale vertically to meet demand, such as databases. While these tools are rarely loaded all the time, they need access to many CPU threads to deliver needed performance. By consolidating the applications onto large-scale servers that provide massive vertical scalability, such as Oracle's Sun SPARC Enterprise M-Series servers, companies can support current workloads and future growth while reducing operating expenses.

For example, consider an environment with 40 previous-generation 8-way systems, each running a database application. The 40 applications have uniform environments and consist of many of the same programs and services. The entire set of applications can be consolidated onto a single 16-way Sun SPARC Enterprise M-Series server using a single database license. Using the resource management facilities in Oracle Solaris Containers, companies can divide the massive processor and memory resources of the server among the containers to ensure no application is starved for resources. As a result, companies get move from a large number of grossly underutilized servers to a single server that is utilized more effectively. Note that a container is considered a license boundary for many enterprise applications, including Oracle software. Consequently, moving to a container-based solution can save money over solutions that license applications based on the number of sockets or cores in the system.

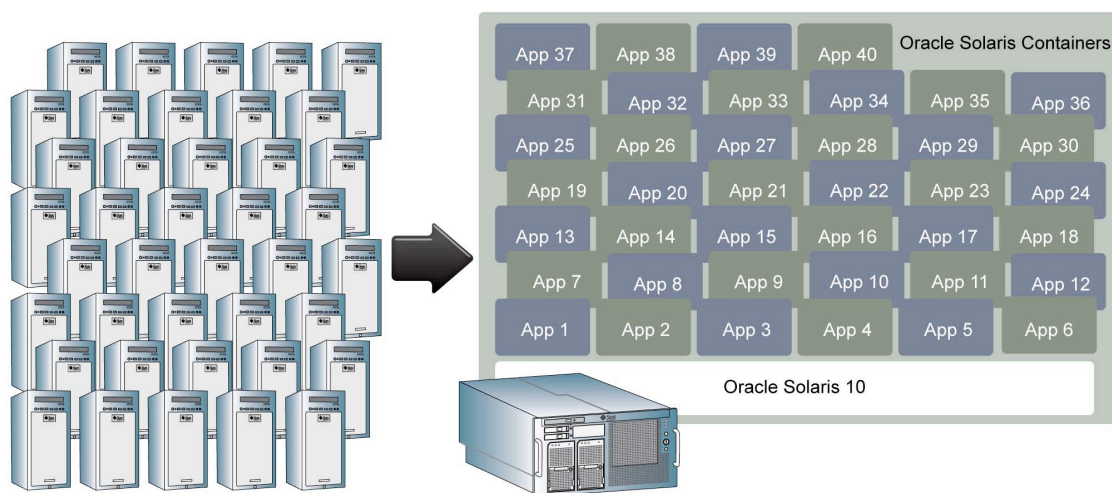


Figure 4. Consolidating onto a vertically scalable server can help companies save money while keeping headroom available for growth

Create a More Agile Datacenter

Whether for planned maintenance, disaster recovery purposes, adoption of new hardware, or efforts to improve server utilization, organizations often need to migrate an entire software stack from one server to another. For example, moving resources on demand to meet business changes, such as nighttime processing or peak load conditions, can make a difference to the bottom line. To help this effort, Oracle Solaris Containers and Oracle VM Server enable virtual environments to be migrated from one machine to another. Applications can be moved onto fewer systems to maximize utilization, with unneeded systems turned off to save energy.

The ability to migrate applications quickly holds promise for companies with under-utilized systems. In fact, many industry analysts estimate that most systems are run at only 15% of capacity. By moving entire software stacks from one platform to another, administrators can regularly adjust consolidated platform workloads and maximize the use of every compute resource. Consider a software company with development, test, and production systems. Applications need to be able to move throughout the build, test, and deploy chain in a timely manner. With Oracle Solaris Containers, applications can be developed in an isolated environment and packaged for movement to the testing systems. Shared storage makes it possible for the transition to happen quickly, and applications do not need to be duplicated. Once tested, applications can be moved quickly to production systems. With these capabilities, organizations can experience rapid roll out of applications, little downtime, and automatic roll back to development and testing systems when needed.

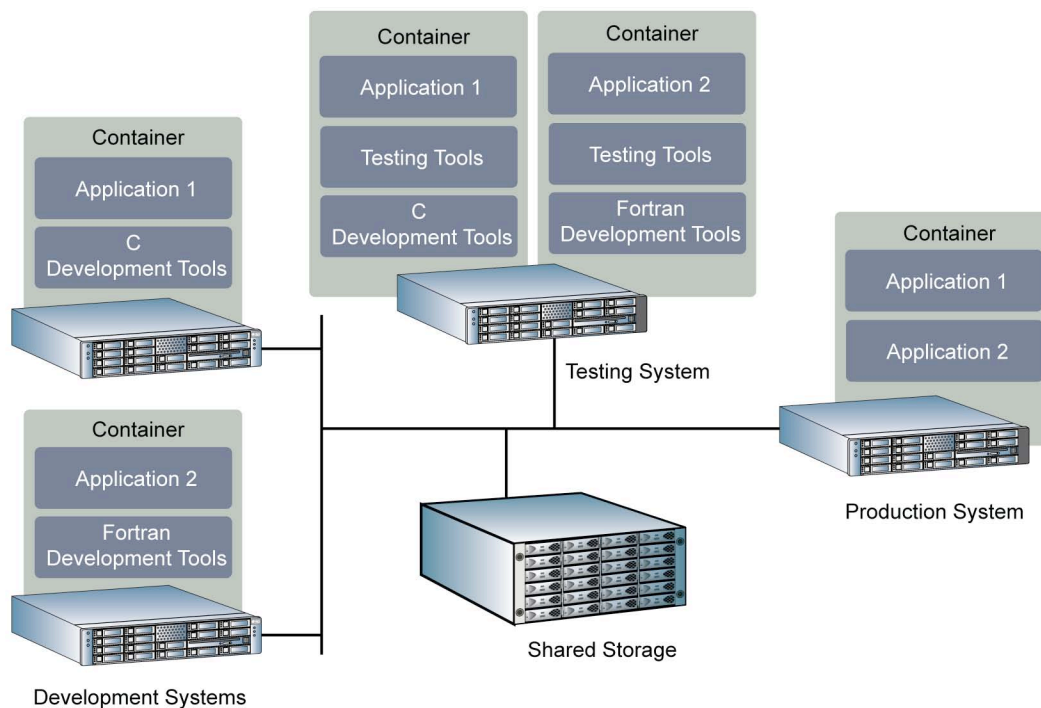


Figure 5. Oracle Solaris Containers can be moved between systems quickly and easily

These scenarios also can be implemented using the warm migration features of Oracle VM Server. Guest domains can be migrated from one server to another compatible server over a secure connection. If running, the domain on the source server is suspended, and its configuration and run-time state are transferred to another server, where the domain is recreated and resumed. Bound domains and those that are not running also can be migrated almost instantaneously, as only the domain's configuration needs to be transferred and recreated. By using domain migration, the domain hardware description, operating system, and applications can be redeployed quickly to a domain on another platform (Figure 6).

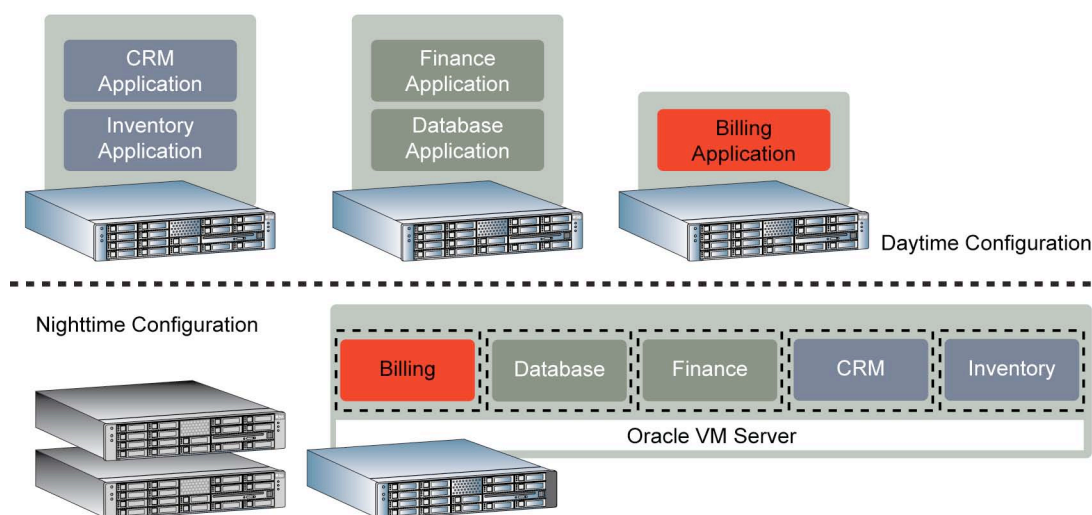


Figure 6. Applications can be moved in Oracle VM Server environments to better utilize systems and conserve energy

Speeding Application Throughput

Many organizations run applications across distributed systems in order to speed application throughput. While this approach proves helpful by getting multiple systems to work on tasks in parallel, inter-server communication can slow results. By moving application components into a virtualized environment with Oracle Solaris Containers, organizations can deliver performance improvements and utilize fewer hardware resources. Placing the applications on newer platforms lets the software take advantage of hardware performance advancements, such as higher processor speeds, and large memory—and speed inter-process and inter-application performance by eliminating server-to-server communication across a network.

Consider an environment with six machines that work together to provide a service. The service consists of six components—each running on a separate system—that communicate with one another over a network. The six processes can be placed near each other on a single server using Oracle Solaris Containers (Figure 7). Because the processes all reside on the same system, process-to-process communication no longer needs to take place over the network. By moving to a new system and using it in a different way, latency is reduced dramatically, resulting in massive gains in application throughput.

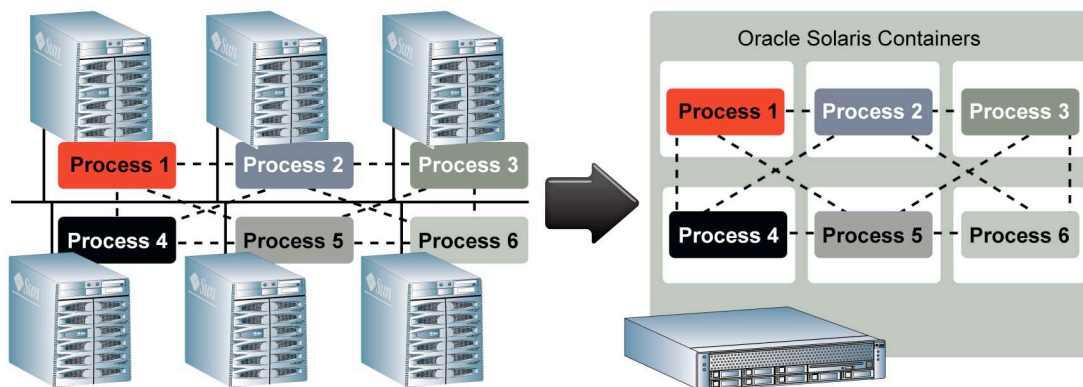


Figure 7. Moving applications closer to one another can help speed application throughput

For example, Thomson Reuters was looking to deliver increased capacity, improved efficiencies, and reduced latency to financial services professionals using Reuters Market Data Systems on Oracle Solaris platforms. By moving the application to a virtualized environment based on Oracle Solaris Containers and multicore platforms, the company was able to demonstrate better performance than that achieved using a number of individual servers. With this move, the company was able to improve on recent performance enhancements to deliver unprecedented levels of updated throughput while continuing to deliver the same levels of superior low latency performance in a scalable fashion. For more information on project, see <http://www.sun.com/third-party/global/thomsonreuters/index.jsp>.

Protect Web-Facing Applications

In today's hyper-connected economy, every company has or wants a Web presence. The increasing availability of networks, bandwidth, and digital devices makes it attractive—and easier—to offer more applications and services to employees, customers, end users, and consumers over the internet or corporate intranet. As users gain comfort with this new model, the appetite for new and more sophisticated network-based services continues to grow. With pressure on to create and deploy more network services faster, many companies skip or shorten the testing process, making these applications targets for hackers looking to deface Web sites or steal information.

Companies looking to protect Web-facing applications can use the access control mechanisms built into Oracle Solaris 10. These features—such as Oracle Solaris Containers, User and Process Rights Management, and the Oracle Solaris Service Manager—run equally well on Oracle's SPARC and x86/x64 platforms—and can help to keep systems and services safe. With these tools, administrators can consolidate and secure multiple functions on a system without the need to modify application source code. In this scenario, the system is configured with two Oracle Solaris Containers. One container hosts data and is connected to the corporate intranet or LAN. The other container holds the Web server and is configured with a reduced set of privileges. While the Web container is accessible to the public internet through a firewall, it has read-only access to the files contained in the data container to help protect HTML and data files (Figure 8). As a result, intruders that hack into the system are unable to modify the IP address or corrupt other system data.

Environmental settings also are important to control. With Oracle Solaris Containers, administrators can configure critical parameters for each container, such as separate network connections with exclusive IP stacks and disk storage, to give each virtual environment a unique identity and maintain resource and name space isolation. To further secure the deployment, User and Process Rights Management can be used to give applications access to only the system resources needed to function. In addition, the Oracle Solaris Service Manager can be used to specify the run-time attributes for the Web server, such as the privilege and user settings used when running the service, to place constraints on the execution of the software. Together, these and other Oracle Solaris tools give organizations fine-grained control over rights and resources within a consolidated server without increasing the number of operating system instances to manage.

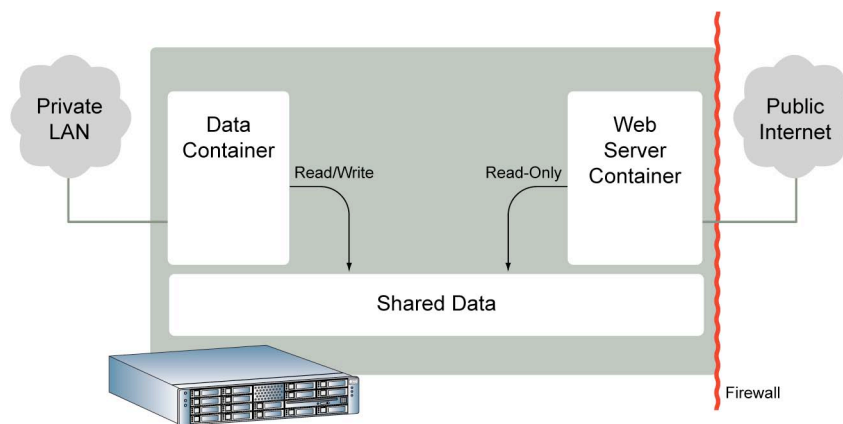


Figure 8. A typical configuration that prevents Web page hijacking

Rapid Deployment with Templates

Purchasing, configuring, provisioning, and deploying systems and services can be a time-consuming task. Enterprise software often contains numerous components or modules, each of which may need to be installed and configured separately—with its own dependencies on patches, operating system versions, or other packages. Learning how to install products and researching needed patches can be a lengthy process. Furthermore, application complexity can result in the risk of something being overlooked or done incorrectly. The entire process often is viewed as a cost burden that reduces project ROI by lengthening the time it takes to get an application or service up and running reliably.

Oracle's virtualization technologies can be used to simplify application deployment. Using Oracle Solaris Containers or Oracle VM Templates, companies can rapidly and easily deploy one or more pre-built, pre-configured, pre-patched virtual environments and their application stacks. For example, Oracle VM Templates contain a complete Oracle software solution, such as Siebel CRM or Oracle Database, including the operating system and third-party software. Within these templates, Oracle software is laid out in the same manner as the software would be if it were installed and patched using traditional methods.

The exact directories and Oracle homes are used, and the package and patch inventories are completely standard and up-to-date so that no changes to normal Oracle operations procedures are required to maintain the instances over time. Administrators simply download the template file from the *oracle.com* site, decompress it, and import the resulting template into Oracle VM Manager to create virtual machines (Figure 9). Enterprises can even create their own templates to speed the replication and deployment of entire enterprise software stacks.

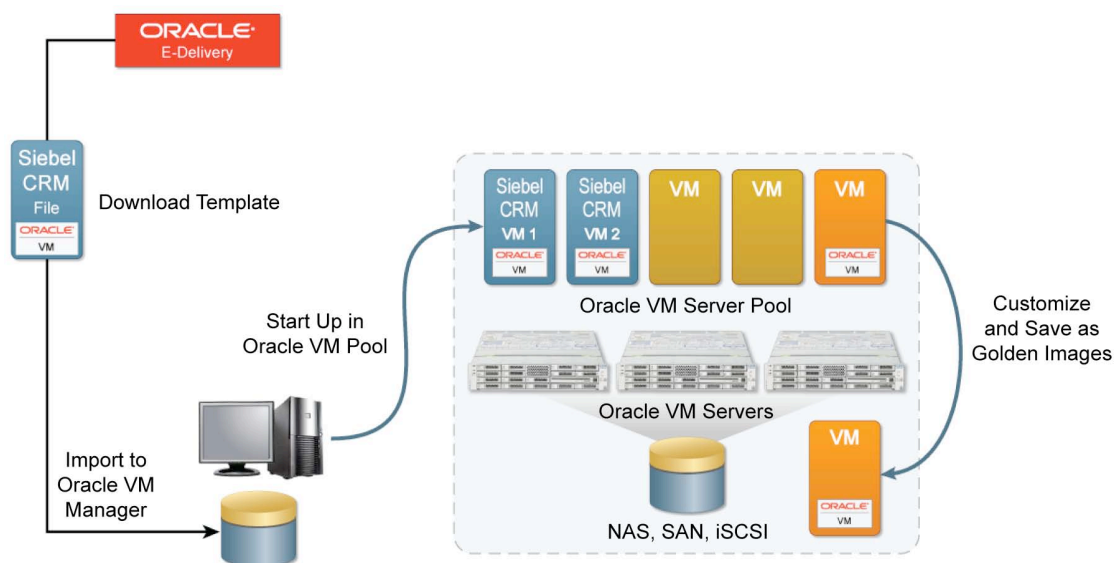


Figure 9. Oracle VM Templates can be used to replicate entire enterprise application stacks to virtual environments

For More Information

More information on the virtualization technologies available on Oracle Solaris 10 platforms can be found in the references listed in Table 1.

TABLE 1. REFERENCES

Oracle and Sun Virtualization Strategy	http://oracle.com/virtualization
Oracle Technology Network	http://www.oracle.com/technology/index.html
Sun Microsystems Documentation	http://docs.sun.com
BluePrints Community	http://www.sun.com/blueprints



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