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# Best Practices for Moving to the Oracle<sup>®</sup> Solaris 10 Operating System

Best Practices for Oracle Solaris 10 in the Datacenter

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## Executive Overview

This white paper provides an overview of the technologies and approaches available when upgrading to the Oracle® Solaris 10 operating system—from a simple system upgrade to a consolidation strategy using built-in virtualization technology. It discusses the upgrade options available, issues to consider, planning the upgrade, and strategies for implementation. References to other papers and articles with deeper detail are provided.

## Introduction

Technology refresh cycles are a necessity, and can help companies take advantage of new innovations and operate at peak performance. While most companies associate such efforts with upgrading servers and systems, the operating system also plays a key role and can help organizations create more efficient deployments if kept up to date. For example, technologies that are built into the operating system can help organizations shape the operational structure of the IT environment to meet business priorities. Virtualization tools can help improve efficiency. Clustering technology can facilitate the creation of highly available deployments. Oracle Solaris role-based access controls can foster greater system security, and data management can be improved through the use of a different file system.

Upgrade processes often are met with apprehension. Seen as taking excessive effort and introducing risk, infrastructure software upgrades are often avoided whenever possible. When platforms appear to be functioning correctly—if not optimally—many organizations opt to leave systems and services alone. Doing so can keep companies from knowing about, and taking advantage of, technological advances. Upgrading to the Oracle Solaris 10 OS offers system architects and administrators several technologies that can drive efficiency, and can be straightforward when carefully planned, tested, and implemented.

## Why Upgrading to Oracle Solaris 10 is Different

Oracle Solaris 10 includes a wide range of capabilities and cost-saving features that can help companies optimize the datacenter and save money. With these built-in tools, organizations can create more effective system and storage deployments, virtualize and consolidate applications, deliver optimized resource utilization and improved performance, detect and correct faults before they result in application failures, and protect applications with greater security. This applies whether upgrading from older releases of Oracle Solaris, or from other operating systems with fewer built-in features for reliability, resource management, and virtualization.

Upgrading older versions of Oracle Solaris to Oracle Solaris 10 is straightforward. All Oracle servers run Oracle Solaris, providing upward compatibility within each processor family. Whether upgrading existing systems or moving to new hardware, companies can rest assured that existing applications can run in the new environment. This protects hardware and software investments while lowering development, testing, and deployment costs. Moving from other operating systems is straightforward as well, as the Oracle Solaris OS is supported on industry-standard servers from other computer manufacturers, and provides a broad portfolio of applications to replace or upgrade legacy systems.

## Reclaim Valuable Datacenter Floor Space and Save Money

Older systems pose operational challenges, and are larger and less efficient. With datacenter energy resources and floor space at a premium, systems that consume too much power, generate excessive heat, and occupy significant floor space make balancing datacenter resources and budgets difficult. As these systems age and approach the end of their service life, escalating management, maintenance, and service costs become prohibitive.

Upgrading existing systems, or moving to the latest systems that run the Oracle Solaris 10 OS, can help companies take advantage of new consolidation and virtualization technology, performance enhancements, and space- and energy-efficiency innovations in the hardware and software. Oracle Solaris 10 contains built-in virtualization features, making it ideal for server consolidation without incurring costs for additional virtualization technology products. The operating system also includes the Oracle Solaris ZFS, which helps improve performance and data integrity, and eliminates the need for expensive third-party volume managers.

## Get More Out of Existing Systems

With many systems only operating at 10% to 15% of capacity, finding ways to harness untapped compute power can help justify investments. Many of the existing systems currently running the Oracle Solaris 8 OS or Oracle Solaris 9 OS can be upgraded to the Oracle Solaris 10 OS, letting organizations take advantage of the consolidation, virtualization, and resource management facilities built into Oracle Solaris 10 to better utilize existing systems.

Consider an organization with three servers, each with a maximum load of 25% to 30% of capacity. If each application runs on its own Oracle Sun Fire V880 server running Oracle Solaris 8 or Oracle

Solaris 9, a significant percentage of compute capacity remains unused on each server. By upgrading one of the servers to Oracle Solaris 10, separate execution environments can be created on the system for each application.

Consolidation technology built into Oracle Solaris 10 keeps failures in one execution environment from impacting the applications in other execution environments, and ensures applications do not starve one another of resources. As a result, organizations can run multiple applications on a single server and share compute and memory resources to affect better resource utilization. For example, consider 10 lightly loaded servers running the Apache Web Server on Red Hat Linux or an older version of Oracle Solaris. These servers can be consolidated into securely isolated and virtualized environments on fewer Oracle Solaris 10 instances, potentially reusing one or more of the original servers for reduced operational costs.

### Support Application Upgrades and Patch Levels

Most of the latest versions of key enterprise applications require underlying systems to run Oracle Solaris 10. Many vendors require organizations to run the latest versions of applications in order to maintain vendor support for security and software patches. While application upgrades can require additional license fees, these costs are outweighed by the risks associated with falling further behind in application functionality and software support.

By upgrading to Oracle Solaris 10, IT departments can eliminate the burden of managing the patch history for older operating systems, and take advantage of bug fixes and patches built into the latest release. In addition, advanced technology available in the latest release of Oracle Solaris 10 can help IT organizations to support a more efficient deployment infrastructure.

## Planning and Performing the Upgrade

Careful planning, testing, and implementation can speed and simplify the upgrade process and minimize risk. The next section describes a methodology and process for creating and operating an upgrade project. It may duplicate processes already in place, or be too heavyweight for some institutions. Use it as a guide for establishing an enterprise datacenter upgrade project, and adopt the portions that are applicable to the environment.

### Understand the Existing Environment

The elements of the enterprise infrastructure stack support one another. If the facilities do not provide adequate power or cooling, problems can arise in the computing and storage platforms. If the computing and storage platforms do not support the application infrastructure, applications cannot function properly or meet service-level agreements. If servers are under-utilized, costs can escalate and prevent the business from realizing the expected return on investments.

## Evaluate Applications and the Environment

The upgrade path must be based on application requirements and how applications fit into the overall IT environment. As a result, it is important to evaluate the existing infrastructure to determine what supporting infrastructure, utilities, or scripts are needed in the new environment to ensure applications meet service-level agreements (SLAs) for availability and throughput. Test plans must be in place to ensure the new environment meets or exceeds the performance and functionality of the existing environment. In addition, measure the existing environment for current TCO, resource utilization, and space and power consumption levels so that the new environment can be evaluated in comparison.

### Best Practices

- Evaluate the existing infrastructure
- Determine the supporting infrastructure, utilities, or scripts that are needed
- Create test plans
- Measure the existing environment to set a baseline for comparison

## Establish and Prioritize Objectives

With any large or complex undertaking, it is important to define and document the business, financial, and technical objectives and scope of an upgrade project in a clear manner. Addressed too broadly, the project can fail to meet user expectations; defined too narrowly, it might not bring the benefits the organization requires. Balancing the objectives and scope with the technical upgrade strategies is the key to a successful project.

Set and prioritize measurable objectives for an upgrade project. A major pitfall when setting upgrade project objectives is failing to define measurable objectives that can be closely followed and fit into a specified time frame. An example objective: upgrade to the current version of Oracle Solaris 10 by a given date, and implement Oracle Solaris Containers and resource management within 30 days of the upgrade. If the improved performance and resource utilization of Oracle Solaris 10 is part of the project's goals, measure performance and system utilization before the upgrade as a baseline. Repeat measurements after the upgrade to quantify and validate improvements.

## Define a Value Proposition

A project's value proposition should be stated in terms that are meaningful to stakeholders, justify investment in the project, and relate to the measured objectives. For example, if the inability to meet SLAs is a primary driver for an upgrade project, the upgrade should produce improved quality of service (QoS) or improved service levels. Addressing the business driver as a value proposition can help determine which upgrade paths and technologies best satisfy business needs. If the upgrade to Oracle Solaris 10 is motivated by its improved performance relative to older versions of Oracle Solaris or other operating environments, then the value proposition should state the value in business terms, such as improved customer response times or the ability to meet increasing throughput requirements.

## Understand Risks and Plan Contingencies

Risks are inherent in any IT project. To minimize risk in the upgrade process, follow a risk management technique. While many different techniques exist, most include the following components.

- **Risk identification.** States all business, technical, and project risks so that they can be evaluated.
- **Risk estimation.** Assesses each identified risk and measures the possible effects each risk can have on the business or project. Each risk must be categorized by the severity of its impediment to the success of the project.
- **Risk evaluation.** Evaluates and prioritizes risks to the upgrade project. Risk evaluation helps organizations to focus on risks that pose the greatest threats.
- **Mitigation and contingency plan creation.** Helps to reduce risk during the upgrade process by outlining the recourse to take should a problem arise. Risk mitigation steps should involve vendors early in the process, contract outside experts (if needed), and review steps and application changes. Contingency plans should be available in case mitigation efforts do not lead to a successful upgrade. Contingency plans can include outsourcing upgrade tasks to a skilled vendor, re-evaluating the strategy for the upgrade project, and falling back to a legacy solution. A contingency plan needs to be documented, tested, and approved during project planning so that it can be executed as an option should the need arise, not as a panic response that precipitates scores of other emergencies.

Risk decreases as more knowledge is gained through an assessment of the upgrade opportunity. Risk is high if little is known about the application(s) and the associated infrastructure. Risk levels fall dramatically if time and effort have been invested into understanding the environment. The effort expended during an assessment should be directly related to the level of risk the organization is willing to accept. This should be balanced against the costs the organization is willing to pay in terms of the labor and organizational disruption caused by the assessment activity.

### Best Practices for Minimizing Risk

- Identify and assess business, technical, and project risks
- Understand the possible effects risks can have on the business or upgrade project
- Focus on the risks that pose the greatest threat
- Construct contingency plans

## Select the Upgrade and Virtualization Path

No two applications are exactly alike or place the same demands on underlying infrastructure. As a result, datacenters often run applications on different types of systems in order to meet SLAs and ensure application needs can be met. These requirements can dictate whether systems, or groups of systems, need to follow different upgrade paths. This section provides an overview of the primary methods for upgrading to Oracle Solaris 10, including factors to consider, trade-offs in the approaches, evaluation of platform choices, and application and technology considerations.

## Move to a New Platform

Whether for planned maintenance, disaster recovery purposes, adoption of new hardware, or efforts to improve server utilization, organizations often need to move an entire software stack from one server to another. When systems reach their end of life, or their cost is fully amortized, it often makes both financial and technological sense to upgrade to a new system. In some cases, new server capabilities, application demands, or datacenter operational pressures require the move to newer systems.

Moving to a new platform consisting of the latest hardware and the latest operating system can be used as part of a rolling upgrade strategy. While this approach is particularly well suited to stateless, horizontally-scaled applications that are left unchanged until replaced, it also can be used for stateful, vertical systems.

When a new server is needed, it is important to understand application workloads and match them to platform characteristics to help select the right system for the task at hand. For example, application threading, vertical scalability, reliability, flexibility, and cost are key factors to consider when deciding whether to upgrade to Oracle's servers with CoolThreads technology, Oracle's Sun SPARC Enterprise® M-Series servers, or Oracle's x86 servers running Oracle Solaris 10. Table 1 describes some of the key characteristics of Oracle servers and their supported virtualization technologies that can influence the upgrade path. Consult a local Oracle Sales Engineer or authorized Oracle reseller for help in evaluating platforms for a given environment.

While upgrading to a new system brings with it additional acquisition costs, it can offer a non-disruptive upgrade process. Since the original system is not modified, organizations have a built-in fallback option (the old system). Upgrades can be performed and tested offline and in parallel with running production systems. However, more complex logistics are required when performing the cutover from the old system to the new system. Application data must be synchronized, and some data may need to be replicated from the old system to the new one—a task that can be difficult depending on business cycles and data sizes. In addition, clients may need to be updated to point to the new hostname or IP address (and the reverse in the event of a fallback to the old system).

### Best Practices

- Understand application workloads and match them to platform characteristics
- Consider application threading, vertical scalability, reliability, flexibility, and cost when selecting a new system



TABLE 1. ORACLE SERVER FAMILY CHARACTERISTICS AND VIRTUALIZATION OPTIONS THAT INFLUENCE PLATFORM SELECTION

	SYSTEM CHARACTERISTICS	VIRTUALIZATION TECHNOLOGIES AVAILABLE
<b>ORACLE SERVERS WITH COOLTHREADS TECHNOLOGY</b>	<ul style="list-style-type: none"> <li>• UltraSPARC® T2 or T2 Plus processors</li> <li>• Up to 4 CPUs</li> <li>• Up to 8 cores per CPU, 8 threads per core</li> <li>• Up to 256 threads per system</li> <li>• Chip Multithreading (CMT) Technology</li> <li>• Up to 512 GB memory</li> <li>• Up to 1.2 TB internal disk storage</li> <li>• Up to 128 GB internal SSD storage</li> <li>• Up to 4 10/100/1000 Mbps Ethernet ports</li> <li>• Up to 2 optional Gbps Ethernet ports</li> <li>• Up to 28 PCIe slots (with expansion modules)</li> </ul>	<ul style="list-style-type: none"> <li>• Oracle Solaris 8 Containers</li> <li>• Oracle Solaris 9 Containers</li> <li>• Oracle Solaris Containers</li> <li>• Oracle VM Server for SPARC</li> </ul>
<b>SUN SPARC ENTERPRISE M-SERIES SERVERS</b>	<ul style="list-style-type: none"> <li>• UltraSPARC SPARC64® VI, or SPARC64 VII processors</li> <li>• Up to 64 CPUs, 8 threads per CPU, up to 512 threads</li> <li>• Processor mixing on select models</li> <li>• Up to 4 TB memory</li> <li>• Up to 19 TB internal disk storage</li> <li>• Up to 128 GB internal SSD storage (on select models)</li> </ul>	<ul style="list-style-type: none"> <li>• Oracle Solaris 8 Containers</li> <li>• Oracle Solaris 9 Containers</li> <li>• Oracle Solaris Containers</li> <li>• Dynamic Domains</li> </ul>
<b>ORACLE X86 AND X64 SERVERS</b>	<ul style="list-style-type: none"> <li>• Intel® or AMD™ processors</li> <li>• Up to 8 CPUs, up to 6 cores per CPU</li> <li>• Up to 512 GB memory</li> <li>• Up to 48 TB internal storage</li> <li>• Up to 4 10/100/1000 Mbps Ethernet ports</li> <li>• Up to 6 PCI Express slots</li> <li>• Up to 8 low-profile PCI expansion slots</li> </ul>	<ul style="list-style-type: none"> <li>• Oracle Solaris Containers</li> </ul>

### Move to a New Platform, Run Applications in an Existing Environment

Enterprises depend on a wide variety of applications in order to get work done. While business operations or datacenter priorities often dictate the move to newer systems, some times it is impractical or too expensive to upgrade applications. In this case, datacenters can upgrade to the latest server hardware running Oracle Solaris 10 and take advantage of Oracle Solaris Container technology to provide virtualized Oracle Solaris systems on the same server (Figure 1). Oracle Solaris Containers provides highly scalable Oracle Solaris OS virtualization with native operating system performance levels. Organizations optionally can run existing applications that are certified for Oracle Solaris 8 or 9

in virtualized execution environments that look and operate like the older versions of the operating system. While simpler than a full stack upgrade, this approach creates a more complex deployment and vendor support for licensed software may or may not be available for the virtualized environment.

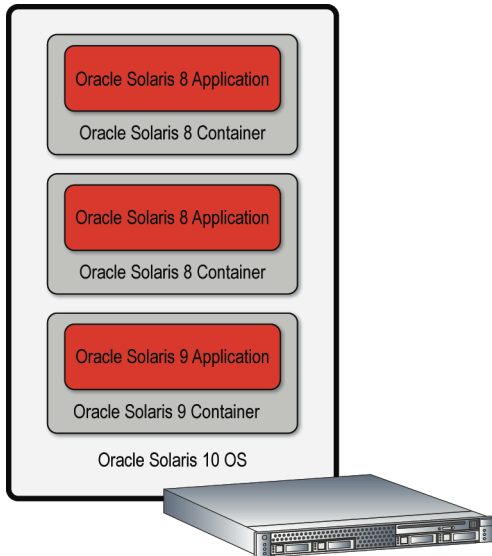


Figure 1. Older applications can run on new hardware inside Solaris Containers.

### Architect New Infrastructure

When new projects arise, creating new infrastructure with the latest systems and Oracle Solaris 10 can simplify integration with existing Oracle Solaris platforms and take advantage of the latest Oracle Solaris 10 consolidation, virtualization, and data management innovations. In general, this is the easiest and least risky upgrade path to new infrastructure. It eliminates the headaches and costs associated with migrating to different platforms and architectures—issues with porting code, retraining people, rearchitecting the surrounding infrastructure such as backup and monitoring, hassles with procuring new hardware and support contracts, and more.

### Consolidate Workloads Using Existing Hardware

Consolidation strategies are emerging as a key tool in the fight to regain compute capacity and datacenter energy resources, and control budgets. Oracle Solaris 10 supports a wide range of consolidation and virtualization technologies. Organizations can combine applications from multiple servers onto an existing system with low usage rates in order to tap unused CPU resources and improve resource utilization (Figure 2).

Several key issues must be considered.

- The existing system must be upgraded to Oracle Solaris 10. Doing so requires backing up the system, installing the Oracle Solaris 10 OS, choosing and configuring a virtualization technology, and moving applications and data to the newly upgraded system.
- The server to be upgraded must have adequate CPU, memory, and disk capacity to support all of the applications that are going to run on the system. Careful analysis and capacity planning is critical for a successful consolidation project when combining multiple workloads.

If managed correctly, this methodology can help limit risk as the original environment remains unmodified and can be used while consolidation and administrative tasks are being performed, limiting downtime and providing a fall back position.

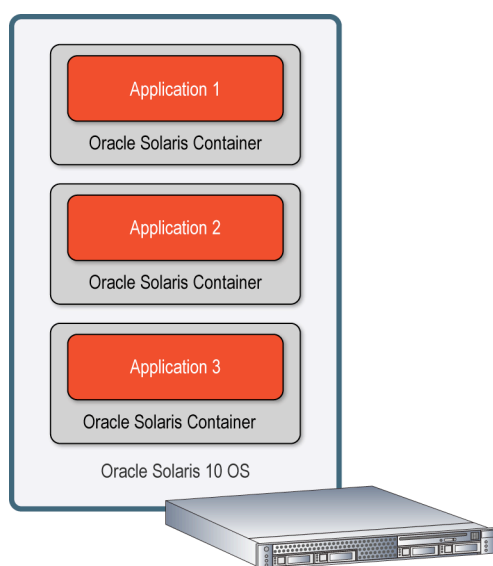


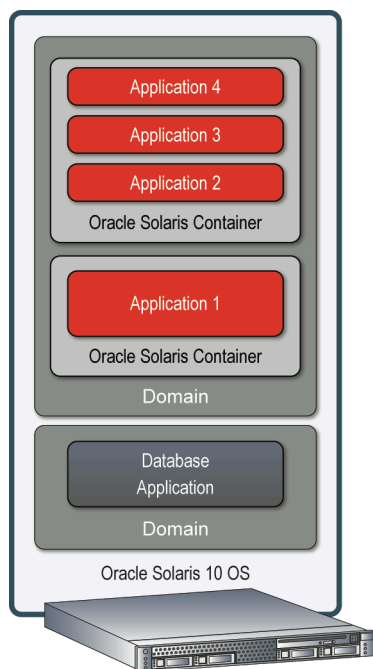
Figure 2. Applications can be combined onto an existing server to optimize resource utilization.

### Consolidate onto New Hardware

As IT organizations add systems to support datacenter loads, unplanned growth has resulted in sprawling, complex network of systems that consume valuable datacenter floor space, create excessive power and cooling demands, and are costly and difficult to manage. Today many of these platforms are reaching the edge of their capacity, making it difficult for datacenters to depend on systems and scale solutions to meet service-level agreements. Power consumption is at an all-time high, with little or no headroom for additional servers and storage systems.

Consolidation techniques, in combination with virtualization strategies, can be used to bring applications, databases, and services together onto fewer, highly reliable servers in order to garner efficiency and lower costs (Figure 3). While consolidation can create a more complex solution, initial upgrades are not disruptive. The original system is not modified, giving organizations a built-in fallback option should a problem arise during the upgrade process. In addition, consolidation offers a better

opportunity for cost savings than a one-to-one system replacement. Placing multiple applications on a single system saves on CPU, software license, and energy costs, as well as datacenter floor space. The potential savings are so great that consolidation onto a new platform is almost always worth the effort.



**Figure 3. Virtualization technologies can be used separately or together to get the right level of application isolation and environment characteristics.**

The following best practices should be considered when performing an upgrade to a new platform.

- Understand the resource management capabilities of Oracle Solaris 10, and the virtualization technologies available, before implementing a solution. A variety of techniques are available. Selecting the right approach can have a dramatic impact on reducing costs while increasing performance and flexibility.
- Start with one or more applications that are not mission-critical until system administrators come up to speed on the new environment
- Know what SLAs are in place to satisfy user demand. To ensure SLAs can be met, undertake a capacity planning exercise to ensure the new system(s) can handle the workload, including day-to-day operations and peak conditions.
- Select the right file system(s) for the data in use. Oracle Solaris 10 supports a wide variety of file systems, each designed to handle different types of file access. Key file systems to consider are the Oracle Solaris ZFS file system, UNIX<sup>®</sup> file system (UFS), and the Sun QFS shared file system.

### Upgrade Existing Systems in Place

Perhaps the least desirable and most risky option available to datacenters is upgrading existing systems. In some cases, servers may be performing well enough that buying new hardware is not a necessity. In other environments, datacenter budgets may not permit the acquisition of new hardware. Some systems may be decommissioned—or if new enough to be economically and technically appropriate—repurposed and upgraded to the Oracle Solaris 10 OS.

Upgrading existing systems to Oracle Solaris 10 avoids acquisition costs and keeps application changes to a minimum. Using the same host can minimize disruption to users. Networked applications continue to interact with the same host, and data can remain on existing systems. In addition, keeping the same hardware and changing only the operating system provides a baseline for a performance and stability comparison.

Depending on how the upgrade process is engineered, the original system can be offline for upgrading and testing the system. The upgrade should be planned to reduce the impact of planned outages, and must mitigate risk by providing a fallback in case of difficulty. In addition, the resulting platform may be based on older hardware that often is less cost-effective and has lower performance than newer systems.

The following best practices should be considered when performing an upgrade to a new platform.

- Conduct a testing and upgrade cycle to determine if the existing hardware can meet business priorities and user demand. In many cases, the latest hardware provides improved price/performance and reduced TCO and maintenance costs.
- Check the compatibility and support matrix to make sure that key applications can run on this combination of hardware and software. If the application in question is due to be sunsetted or replaced in the near future, it's probably not worth the effort or risk associated with upgrading the system. Wait until the application upgrade takes place to upgrade the system.
- Use the Oracle Solaris Live Upgrade software to ensure a fallback position is available. Oracle Solaris Live Upgrade lets system administrators upgrade or install newer versions of Oracle Solaris and application software onto an alternate boot environment without altering the running environment. It can be run during normal operational hours without interrupting service. Datacenter staff can boot into the updated environment with only a short interruption of service, and then fall back to the original system software environment if problems are encountered.
- Take advantage of training, professional services, and partners to facilitate the upgrade process, if needed.

Table 2 summarizes the primary upgrade and virtualization paths available. More information on selecting the right upgrade and virtualization path can be found in the *Moving to Oracle Solaris 10* white paper.

TABLE 2. SUMMARY OF COMMON UPGRADE PATHS

UPGRADE EXISTING SYSTEMS IN PLACE	PLATFORM	<ul style="list-style-type: none"> <li>Same or repurposed hardware (if capacity exists)</li> </ul>
	PROS	<ul style="list-style-type: none"> <li>Saves on acquisition costs</li> <li>Keeps change to a minimum</li> <li>Provides a basis for performance and stability comparison</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Poses significant risk if the upgrade process has problems</li> <li>Uses older hardware, performs slower, has higher power, cooling, and maintenance costs</li> </ul>
MOVE TO A NEW PLATFORM	PLATFORM	<ul style="list-style-type: none"> <li>New hardware</li> </ul>
	PROS	<ul style="list-style-type: none"> <li>Useful when using a rolling upgrade strategy</li> <li>Well-suited to stateless, horizontally scaled applications</li> <li>Upgrade can be performed and tested in parallel with production systems</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Requires complex logistics for cutover to new system</li> <li>Requires data synchronization and/or replication</li> <li>Adds acquisition costs<sup>1</sup></li> </ul>
MOVE TO A NEW PLATFORM, RUN APPLICATIONS IN EXISTING ENVIRONMENT	PLATFORM	<ul style="list-style-type: none"> <li>New hardware</li> </ul>
	PROS	<ul style="list-style-type: none"> <li>Runs existing versions of applications on legacy operating system in Oracle Solaris Containers</li> <li>Leverages administrator knowledge of Oracle Solaris 8 and 9 OS</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Creates a more complex deployment</li> <li>Vendor support for licensed software may not be available</li> </ul>
ARCHITECT NEW INFRASTRUCTURE	PLATFORM	<ul style="list-style-type: none"> <li>New hardware</li> </ul>
	PROS	<ul style="list-style-type: none"> <li>Simplifies integration with existing Oracle Solaris platforms</li> <li>Takes advantage of Oracle Solaris 10 innovations</li> <li>Results in the easiest and least risky path to new infrastructure</li> <li>Eliminates costs associated with migration to other platforms</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Adds acquisition costs</li> </ul>
CONSOLIDATE	PLATFORM	<ul style="list-style-type: none"> <li>Same or repurposed hardware (if capacity exists)</li> </ul>

<sup>1</sup> In many cases, acquisition costs can be offset and exceeded by reduced operational costs.

USING EXISTING HARDWARE	PROS	<ul style="list-style-type: none"> <li>Improves resource utilization of existing system(s)</li> <li>Leverages hardware and software investments</li> <li>Saves in CPU, software license, energy, and floor space costs</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Careful analysis of workloads is required</li> <li>Detailed capacity planning is essential</li> </ul>
CONSOLIDATE ONTO NEW HARDWARE	PLATFORM	<ul style="list-style-type: none"> <li>New hardware</li> </ul>
	PROS	<ul style="list-style-type: none"> <li>Results in non-disruptive upgrades</li> <li>Provides a built-in fallback system</li> <li>Offers a better opportunity for cost savings than a one-to-one system replacement</li> <li>Saves in CPU, software license, energy, and floor space costs</li> <li>Offers higher performance</li> </ul>
	CONS	<ul style="list-style-type: none"> <li>Creates a more complex solution</li> </ul>

## Architect the Upgraded Solution

Once an upgrade and virtualization path is selected, the next step is to architect the solution. Assessment, design, and prototyping are pivotal activities at this stage of the upgrade process.

- Assessment.** During the assessment stage, it is important to investigate each layer of the enterprise infrastructure and determine which components need to change in order to meet the goals of the upgrade project. Be sure to evaluate every component in light of the upgrade path selected, and determine which applications, infrastructure components, and processes need to be revised.
- Design.** During the design phase, information gathered during the assessment stage is reviewed. Raw data is evaluated, leading to the identification of key requirements that will drive the design of the upgraded solution. Requirements must be matched with the hardware and software technologies available in the new environment.
- Prototyping.** An optional step, prototyping is designed to provide a proof of concept for the solution architecture. Depending on the amount of risk the organization is willing to take, as well as the upgrade path selected, prototyping may or may not be necessary.

## Implement the Upgrade

The final step in the upgrade process involves implementing and testing the upgraded system. Key steps in the implementation process include:

- **Conduct training exercises.** Train administrators and end users on Oracle Solaris 10 as needed.
- **Acquire new hardware and application software.** If the chosen upgrade path involves moving to new servers or upgrading applications, be sure to obtain the right system configurations and application software versions before proceeding.
- **Install Oracle Solaris 10.** Follow the best practices set forth in the *How to Quickly Install the Oracle Solaris 10 OS on x86 Systems* guide located at [sun.com/software/solaris/howtoguides/installationhowto.jsp](http://sun.com/software/solaris/howtoguides/installationhowto.jsp) or the *Solaris 10 OS Installation Guide* located at [docs.sun.com/doc/817-0544](http://docs.sun.com/doc/817-0544), to speed and simplify the operating system installation process.
- **Configure the configuration and virtualization technologies.** If the upgraded system is intended to host multiple applications, determine how best to separate the applications from one another and assign physical CPU and memory resources to the applications. Next, configure the domains, Oracle Solaris Containers, or Dynamic Domains to meet application isolation and resource consumption goals on the target platform. References listed at the end of this document can assist with these tasks. For large-scale deployments, tools such as Oracle Enterprise Manager Ops Center can be used to monitor and manage physical and virtual resources.
- **Perform data conversion and movement.** Getting data ready for the new environment is different for every application. In some cases, data may need to be converted from an older application format to a newer format. In other cases, data may need to be moved from one set of physical storage devices to another to improve connectivity, information sharing, or performance.
- **Test the newly upgraded system.** One of the most critical aspects of any upgrade project is testing the new system. Be sure to include unit, integration, validity, and performance testing as part of the process. Tests should be run on the existing system prior to upgrading to help ensure test validity and confirm that the existing application deployment can pass. Do not assume that tests that passed previously still pass on the existing system.

For more information on upgrading systems and infrastructure, see *the Solaris 10 Upgrade Resources for System Administrators* located at <http://bigadmin.com/topics/upgrade>.

## Opportunities Offered by the Oracle Solaris 10 OS

Upgrading systems to Oracle Solaris 10 creates opportunities for the datacenter. A wide range of technology advancements are available in the operating system—features and functions that simply do not exist in Oracle Solaris 8 or 9 or other operating environments. These innovations and improvements are designed to help organizations create more efficient and cost-effective infrastructure and solve day-to-day challenges.



## Improve Resource Utilization

Upgrading to Oracle Solaris 10 gives companies access to modern, supported hardware with better performance and environmental characteristics, and lower maintenance costs. But access to the latest hardware innovations is only part of the story.

Consolidation, virtualization, and resource management techniques are now a requirement for most datacenters. With these tools, organizations are better positioned to quickly recover from disasters, reduce time to market for new services, and better utilize existing infrastructure to reduce space, power, and cooling requirements. Several approaches are built into Oracle Solaris 10 platforms—from support for one or more operating system instances, to little or complete isolation, to solutions that range in flexibility and performance characteristics.

- Resource management enhances the benefits and simplicity of running multiple applications on the same server and operating system instance. Controls govern the utilization of CPU, memory, and I/O resources, and let administrators set and enforce policies that guarantee the share of resources that are available to applications.
- Operating system level virtualization allows multiple applications to share the same operating system instance while providing separate security domains for each application. Oracle Solaris Containers combine resource management and virtualization in the Oracle Solaris OS for a no-cost solution that works on every server running the Oracle Solaris OS. On Oracle servers with CoolThreads technology, Oracle VM Server for SPARC partitions hardware resources, including individual CPU threads, for complete isolation between operating system instances, each of which can be configured with Oracle Solaris Containers for additional flexibility.
- Virtual machine monitors provide greater isolation by supporting multiple operating system types and instances on the same machine. Each application can run in its own operating system instance, and a hypervisor gives each application the illusion that it owns a complete, dedicated set of hardware.
- Hard partitions support multiple operating system instances without the overhead of a hypervisor. Available on Oracle's midrange and 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 operating system.

More information on selecting and implementing consolidation and virtualization strategies can be found in the *Consolidating and Virtualizing Systems on Oracle Solaris 10* technical white paper.

## Create a More Efficient Storage Infrastructure

Keeping data readily available is challenging as data volumes continue to skyrocket. To help this effort, Oracle Solaris 10 includes a host of new features—better internal communication, more complete networking, built-in file and data services with data integrity, simplified data management, and integrated storage pooling and volume management—to facilitate the creation of more effective storage infrastructure. With these built-in tools and technologies, companies can solve a wide variety of enterprise challenges.

### Automate Data Services

From simple tactical task-based applications to sophisticated policy-driven solutions, a rich set of data services that are built into Oracle Solaris 10 can help extend, locate, and manage valuable information. For example, snapshots functionality lets administrators can perform backups easily, save the state of a file system at a particular point in time, and recreate it on another machine. Automatic data spanning and reconstruction of corrupted data facilitates storage space utilization and increased data throughput. In addition, built-in compression techniques are designed to help improve storage device utilization.

### Share Access to Data

With data spread across a wide variety of devices located in storage tiers that are managed by many different computing platforms, a variety of storage protocols are needed to access and share data. To help this effort, Oracle Solaris 10 supports a number of block- and file-level protocols, such as Internet SCSI (iSCSI), Network File System (NFS), SAMBA, and Common Internet File System (CIFS).

### Tailor the Environment to Maximize Functionality and Performance

Applications place heavy demands on underlying file systems. The type of application and access patterns can dictate which file system is best suited for the deployment. Oracle Solaris 10 includes a wide range of file systems, including UFS, Oracle Solaris ZFS, Sun QFS shared file system, Sun Storage Archive Manager software, and more.

### Create Hybrid Storage Pools

New storage platforms, such as Oracle's Sun Storage 7000 Unified Storage Systems, combine the strengths of hard disk drive technology with Flash technology-based devices. Flash devices can be placed in a new storage tier to assist hard disk drives by holding frequently accessed data to minimize the impact of disk latencies and improve application performance. Oracle Solaris 10 enables the creation of Hybrid Storage Pools—storage infrastructure that uses enterprise Flash devices to handle certain types of I/O with dramatically reduced latency and hard disk drives for high capacity. This feature lets Oracle Solaris 10 store and access massive data sets with high performance and at lower cost.

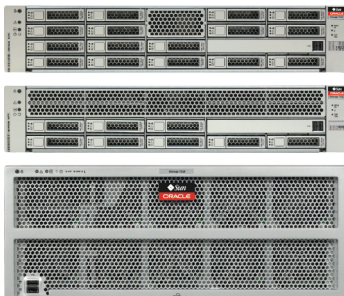


Figure 4. Sun Storage 7000 Unified Storage Systems combine disk drives and Flash devices to help create Hybrid Storage Pools.

### **Simplify Storage Management**

Datacenters employ so many devices—and types of devices—making it difficult to locate, manage, and make available storage solutions and the data they contain. Oracle Solaris 10 supports industry standards for automated discovery, management, and configuration of iSCSI and Fibre Channel devices on a TCP/IP network. As a result, administrators can obtain information dynamically about accessible devices, manage devices with familiar network management tools, enhance security, and adapt to topology changes.

In addition, the Oracle Solaris ZFS file system included with Oracle Solaris 10 is designed to help ease file management complexity. Unlike traditional file systems that require a separate and costly volume manager, Oracle Solaris ZFS integrates volume management functions. Space is shared dynamically between multiple file systems from a single storage pool to allow more efficient use of storage devices. Oracle Solaris ZFS automates many administrative tasks to speed performance and eliminate common errors. Creating file systems is fast and easy. There is no need to configure, or reconfigure, underlying storage devices or volumes—these tasks are handled automatically when devices are added to a storage pool.

### **Increase Data Availability**

Several technologies are built into Oracle Solaris 10 to help ensure data is available when needed. Point-in-time copy technology allows users to create instantly available, time-fixed, replicated views of a volume. Remote replication capabilities can replicate data across IP networks. With this volume-level replication facility, disk volumes can be replicated between physically separate primary and secondary hosts in real time to aid disaster recovery.

### **Improve Availability**

One of the most important functions of an operating system is to maintain availability and data integrity by detecting and handling hardware and software failures. Oracle Solaris 10 includes the Fault Management Architecture (FMA), an advance in error handling that improves system availability compared to other open systems operating environments and previous versions of Oracle Solaris. FMA permits advanced recovery from failures, including the ability to recover in many cases from hardware failures that previously would have caused a system outage,

FMA provides a framework for collecting telemetry for system behavior into a repository, and a fault management architecture that covers first fault detection and diagnosis through successful repair. Error events are sent to a fault manager, which logs the event and uses a diagnosis engine to determine the cause of each failure and route it to the appropriate handler. Fault management commands provide a consistent interface for getting information about system errors, indicating which parts have been replaced or repaired. In many cases, a failing component, such as a CPU or memory module is retired (taken offline) before it fails with an unrecoverable error, making it possible to keep the Oracle Solaris 10 OS running in situations that previously would have resulted in system outages.

## Manage Services with Ease

Operating environments provide and depend on many services, from infrastructure services such as file systems, network stacks, logging, and security, to application services, such as Web and databases. Services typically depend on other services. For example, a Web application service may depend on network and local file system services. Keeping track of these relationships, ensuring that all processes comprising a service are operating, and automating error recovery in the event a service fails can be complex and error-prone.

The methods used in the Oracle Solaris 8 and Oracle Solaris 9 OS, other UNIX, and similar environments can make system and service administration difficult. Oracle Solaris 10 introduces a new and substantively different facility for system and service management—the Oracle Solaris Service Management Facility (SMF)—to simplify the management of system and application services and deliver new and improved ways to control and manage services. Administrators can define the relationships between services, and services can be dependent on one another in order to run. With a new set of administrative interfaces, SMF allows services to be easily and consistently configured, enabled, and controlled—all while providing better visibility into errors, automated recovery from failures, and improved debugging capabilities to help resolve service-related problems quickly.

## Achieve Greater Levels of Security

Oracle Solaris 10 provides a sophisticated network-wide security system that controls the way users access files, protect system databases, and use system resources. From integrated security services and applications, to enhanced encryption algorithms, to an enterprise firewall for network protection, Oracle Solaris 10 sets a high standard for operating system security by addressing security needs at every layer. 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 associated transactions.

- **Harden the system.** Oracle Solaris 10 provides security features previously only found in Oracle's military-grade Trusted Solaris OS, delivering a secure environment right out of the box. However, the system can be further hardened and minimized as needed, helping to reduce the risk that a system or application can be compromised. Reduced configurations can be installed—with fewer software packages, no active networking, a minimum number of running services, and enhanced security. Such configurations not only reduce install time, they also provide a secured building block for customized deployments.
- **Reduce security risks.** Oracle Solaris 10 offers Role-Based Access Control and Process Rights Management. These technologies reduce security risk by granting users and applications only the minimum capabilities needed to perform tasks. System administrators can grant—or deny—a large number of discrete privileges to any process on the system to create effective security policies, minimize the likelihood of hostile actions, control access to data, and ensure compliance with regulatory requirements.
- **Improve data security policies.** An optional layer of secure label technology in Oracle Solaris 10, Oracle Solaris trusted extensions allow data security policies to be separated from data ownership.

With the ability to support multilevel data access policies, the operating system can help companies meet strict government regulatory compliance goals without modifying existing applications for underlying hardware platforms. It provides a platform for deploying high security desktops, database servers, firewalls, and communication gateways, as well as any application where access to sensitive information or networks must be strictly controlled.

- **Take advantage of on-board cryptography.** Provided in Oracle servers with UltraSPARC T1, T2, or T2 Plus processors, on-chip cryptographic acceleration eliminates the need for additional coprocessor cards, special licensing, network appliances, or power hungry add-on components. The cryptographic capabilities of these processors can be accessed via the Oracle Solaris Cryptographic Framework (SCF) that is built into Oracle Solaris 10. SCF provides cryptographic services for kernel-level and user-level consumers, as well as several software encryption modules.

## Optimize Performance

Oracle Solaris 10 offers markedly better application performance than Oracle Solaris 8 or Oracle Solaris 9—even on legacy hardware. An optimized TCP/IP stack, Multiple Page Size Support (MPSS), Memory Placement Optimization (MPO), multithreading advancements, and file system enhancements are available to help companies tune platforms and optimize systems.

The performance gains offered by Oracle Solaris 10 are only part of the performance picture. Oracle Solaris 10 includes an integrated facility for troubleshooting and tuning applications in real time. Oracle Solaris DTrace technology can help isolate bottlenecks and boost application performance.

Additionally, the Oracle Solaris Studio software provides advanced C, C++, and Fortran compiler technologies to further optimize application performance. To learn how Oracle Solaris platforms perform on key benchmarks, see <http://www.oracle.com/us/solutions/performance-scalability/index.html#solaris>.

## How Oracle Can Help

Day-to-day operations leave little time for refresh, upgrade, consolidation, and virtualization projects. Oracle's portfolio of services and programs can help ease the move to new hardware and software platforms.

- **Oracle Solaris 10 support.** While moving to Oracle Solaris 10 can deliver many advantages, the upgrade process is sometimes delayed due to perceived risk, cost, or schedule constraints. Oracle makes the process easier with Oracle Solaris 10 support, services designed to help IT organizations minimize disruption. Oracle experts assess the complexity of upgrading existing infrastructure, identify potential constraints and risks, create a plan, and complete the upgrade.
- **Virtualization Services.** Oracle provides virtualization workshop, architecture, and implementation services that provide assessments, justification, design alternatives, implementation, testing, and knowledge transfer. Oracle consultants assess specific areas where companies want to reduce costs and optimize resources, and recommend an appropriate mix of virtualization technology and IT

processes to help achieve these goals. By implementing Oracle virtualization solutions, organizations can reduce IT costs and improve availability and utilization rates.

- **Oracle Expert Services for Systems.** Oracle provides evaluation, assessment, and implementation services that can help companies adopt a new IT infrastructure or upgrade to Oracle Solaris 10. Oracle consultants carefully analyze and perform system configuration, tuning, optimization, and administrative tasks, along with system moves, changes, and migrations Oracle's system experts provide the extra skills and resources that can help protect IT investments and drive continuous efficiencies.
- **Oracle Advanced Customer Services for Systems.** These services provide deep knowledge in deploying, managing, and optimizing Sun systems from Oracle. Focused on improving performance, increasing availability, and reducing implementation times, these services deliver support and guidance for improving the operating of Sun systems.
- **Global Sun Solution Centers.** Centers around the globe provide enterprises assistance and take the guesswork out of implementing projects. Companies gain easy access to environments for collaborating with engineers and technology experts from Oracle and Oracle partners, tuning applications, testing interoperability and scalability, and more.

## About the Authors

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## References

To learn more about upgrading to Oracle systems and the Oracle Solaris 10 OS, as well as consolidation and virtualization technologies and strategies, see the references listed in Table 3.

**TABLE 3. REFERENCES FOR MORE INFORMATION**

<b>WEB SITES</b>	
Oracle Solaris Operating System	<a href="http://www.oracle.com/solaris">http://www.oracle.com/solaris</a>
Oracle Servers with CoolThreads Technology	<a href="http://www.oracle.com/us/products/servers-storage/servers/sparc-enterprise/cmt-servers/index.html">http://www.oracle.com/us/products/servers-storage/servers/sparc-enterprise/cmt-servers/index.html</a>
Oracle's Sun SPARC Enterprise M-Series Servers	<a href="http://www.oracle.com/us/products/servers-storage/servers/sparc-enterprise/index.html">http://www.oracle.com/us/products/servers-storage/servers/sparc-enterprise/index.html</a> Oracle x64 Servers <a href="http://sun.com/x64">sun.com/x64</a>
Oracle x64 Servers	<a href="http://www.oracle.com/us/products/servers-storage/servers/x86/index.htm">http://www.oracle.com/us/products/servers-storage/servers/x86/index.htm</a>
Oracle Enterprise Manager Ops Center	<a href="http://www.oracle.com/us/products/enterprise-manager/opscenter/index.html">http://www.oracle.com/us/products/enterprise-manager/opscenter/index.html</a>
Oracle Solaris Virtualization Technologies	<a href="http://www.sun.com/software/solaris/virtualization.jsp">http://www.sun.com/software/solaris/virtualization.jsp</a>
BluePrints Community	<a href="http://wikis.sun.com/display/BluePrints">http://wikis.sun.com/display/BluePrints</a>
Oracle Solaris ZFS File System	<a href="http://www.sun.com/software/solaris/zfs.jsp">http://www.sun.com/software/solaris/zfs.jsp</a>
IT Services	<a href="http://www.oracle.com/us/support/systems/operating-systems/index.html">http://www.oracle.com/us/support/systems/operating-systems/index.html</a>
<b>BIGADMIN</b>	
Solaris 10 Upgrade Resources for System Administrators	<a href="http://bigadmin.com/topics/upgrade">bigadmin.com/topics/upgrade</a>
Solaris 10 Applications Library	<a href="http://sun.com/bigadmin/apps">sun.com/bigadmin/apps</a>
Solaris 10 Hardware Compatibility List	<a href="http://sun.com/bigadmin/hcl/data/sol/">sun.com/bigadmin/hcl/data/sol/</a>
<b>ARTICLES AND WHITE PAPERS</b>	
Solaris Containers—What They Are and How to Use Them	<a href="http://wikis.sun.com/display/BluePrints/Solaris+Containers--What+They+Are+and+How+to+Use+Them">wikis.sun.com/display/BluePrints/Solaris+Containers--What+They+Are+and+How+to+Use+Them</a>
The Sun BluePrints Guide to Solaris Containers — Virtualization in the Solaris Operating System	<a href="http://wikis.sun.com/display/BluePrints/The+Sun+BluePrints+Guide+to+Solaris+Containers--Virtualization+in+the+Solaris+Operating+System">wikis.sun.com/display/BluePrints/The+Sun+BluePrints+Guide+to+Solaris+Containers--Virtualization+in+the+Solaris+Operating+System</a>
Solaris Containers Technology Architecture Guide	<a href="http://wikis.sun.com/display/BluePrints/Solaris+Containers+Technology+Architecture+Guide">wikis.sun.com/display/BluePrints/Solaris+Containers+Technology+Architecture+Guide</a>
Working with Solaris Containers and the Solaris	<a href="http://wikis.sun.com/display/BluePrints/Working+with+Solaris+Containers+and+the">wikis.sun.com/display/BluePrints/Working+with+Solaris+Containers+and+the</a>

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The Last Word in File system Just Got Better	sun.com/software/solaris/pdf/zfs_featuresandenhancements.pdf
<b>TRAINING</b>	
Oracle Open Learning Center	http://www.sun.com/global_training/ooc/
<b>MANUALS</b>	
Oracle Solaris 10 OS Reference Manual Collection	docs.sun.com/app/docs/coll/40.10
<b>BOOKS</b>	
Migrating to the Solaris Operating System—The Discipline of UNIX-to-UNIX Migrations	wikis.sun.com/display/BluePrints/%28Book%29+Migrating+to+the+Solaris+Operating+System
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