An Oracle White Paper
April 2010

Moving to Oracle Solaris 10

Best Practices for Oracle Solaris 10 in the Datacenter

Introduction

Although there are many reasons why organizations choose to adopt the next version of an operating system, projects that commonly benefit from an operating system upgrade include the following.

Datacenter technology refresh initiatives that include replacement of obsolete hardware

Plans to upgrade application software to a revision that requires a specific operating system release level

The implementation of a consolidation or virtualization strategy

IT initiatives that aim to improve application performance, reliability, security, or manageability

Moving from Oracle Solaris 8 or Oracle Solaris 9 to Oracle Solaris 10 typically takes two forms. One type of project is the upgrade of a single server that involves no changes to the existing workload or set of hosted applications. This process is relatively straightforward, generally requires no porting, and imposes very few changes to existing administrative procedures and best practices. A second type of upgrade project involves the consolidation of multiple workloads onto a single hardware platform. Although the actual operating system upgrade is straightforward, the overall project involves some additional planning and complexity.

Make the Decision

In some cases, operating system upgrades are delayed as long as possible due to perceived expense in terms of time and money. However, postponing an upgrade to Oracle Solaris 10 delays realization of the benefits that thousands of organizations have already gained by making the transition. Oracle Solaris 10 offers enterprises dozens of additional performance, security, and stability features that can make a real business impact. Several features of

Oracle Solaris 10 can help detect and correct system faults before they result in application failures, optimize resource utilization, improve performance, and protect applications with unparalleled security. Capabilities in Oracle Solaris 10 can help businesses achieve the following:

Simplified datacenter operations

Higher availability levels for business-critical IT services

Reduced costs through consolidation or improved resource utilization

Increased security for valuable corporate data

There are many approaches to rolling out Oracle Solaris 10 across an enterprise. However, some methods are vastly more efficient than others. The scalable processes described in this paper can help organizations complete upgrade projects in a timely manner with minimal disruption to IT services. Whether the goal is to adopt Oracle Solaris 10 throughout the entire datacenter or on one server, this technical white paper can help provide an understanding of the key steps to completing an upgrade project. In addition, detailed descriptions explain how to simplify the process, reduce risk, minimize disruption during the upgrade, and ensure success. Concepts within this document are specific to upgrading from Oracle Solaris 8 or Oracle Solaris 9 to Oracle Solaris 10 and can augment an organization's existing certification process for new operating systems.

Part of a series, this document addresses the following topics:

"Get Ready", highlights the typical structure of an enterprise infrastructure and summarizes the key items to consider while making an assessment of the compatibility of the existing environment with Oracle Solaris 10.

"Architect the New Environment", provides a brief guide to the items to consider before initiating the upgrade. Topics include making a hardware platform selection, considering data migration issues, and identifying virtualization and consolidation opportunities.

"Complete the Upgrade", describes a scalable approach to upgrading any number of systems and summarizes the basic steps needed to perform the actual upgrade to Oracle Solaris 10.

"Take Advantage of Oracle Solaris 10 Technology", highlights ways to start utilizing the advanced features of Oracle Solaris 10 to improve uptime, increase performance, maximize IT asset utilization, and enhance security.

"Summary", offers pointers to additional information and resources.

This technical white paper assumes a basic understanding of Oracle Solaris operating system upgrade processes, and virtualization technology. The content of this document is written primarily for system administrators who are planning to upgrade one or more systems from an older version of Oracle Solaris to Oracle Solaris 10.

Get Ready

As illustrated in Figure 1, enterprise infrastructure consists of many layered parts. The upper portion of the enterprise infrastructure stack includes the business drivers that require support from technology solutions. In the center, the execution architecture consists of the software and hardware components that perform the compute tasks to complete business processes. In the lower portion of the enterprise infrastructure stack, IT people, processes, and tools implement the management infrastructure that controls, measures, monitors, and manages the execution architecture.

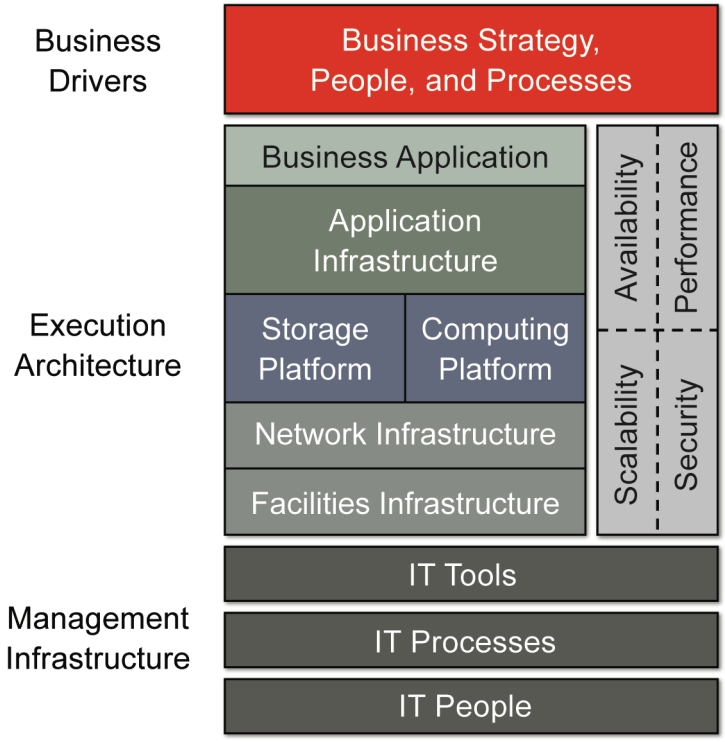

Figure 1. A typical enterprise infrastructure includes many interdependent layers.

The elements of the enterprise infrastructure support each other. For example, 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 software infrastructure, applications cannot function properly. Similarly, if the enterprise architecture does not provide the required functionality in support of the proscribed business strategy certain business objectives may not be met. Given these interdependencies, upgrade projects must consider all layers of the enterprise infrastructure. The sections in this chapter discuss the aspects to consider at each layer of the enterprise infrastructure before starting an upgrade project.

Responding to Business Strategy, People, and Processes

Supporting the Business Strategy, People, and Processes layer of the enterprise infrastructure during an

upgrade project means ensuring that business requirements and service-level agreements continue to be met throughout the project. Care must be taken to ensure the upgrade process does not disrupt business initiatives. At the least, solid communication channels need to be established between the project leads and key business personnel to ensure that important information such as potential downtime windows, testing periods, and upcoming changes can be readily disseminated.

Although a system upgrade is an inherently technical initiative, the operation is usually a top down process. Business application owners typically determine when to upgrade or enhance an application. The IT organization is then engaged to determine the best approach. Roll out of a new operating system throughout a datacenter usually follows a specified order, such as least critical to most critical, by application type, or building by building. Decision criteria may also be based on which applications can realize the most benefit from the capabilities offered by the unique features of Oracle Solaris 10. It is the exception rather than the rule for the IT organization to dictate upgrade policy to the business application owners. Usually, this only happens at the direction of a CFO or CIO, when an enterprise mandate to consolidate or virtualize has been issued.

Evaluating the Execution Architecture

Before initiating an Oracle Solaris 10 upgrade on any particular system, organizations should perform a high-level assessment to evaluate the potential compatibility between Oracle Solaris 10 and key datacenter hardware and software infrastructure components. When evaluating compatibility, it is important to remain flexible and avoid allowing the needs of a single platform to halt progress for the remainder of the systems within the datacenter.

There are a number of layers within the execution architecture to consider, including the following.

The business application layer includes software programs that help perform specific business functions, such as billing, manufacturing, customer relationship management, and inventory tracking.

The application infrastructure layer consists of the following two subcategories.

- Enabling software refers to key software infrastructure components that lay at the foundation of many other enterprise applications. Examples include Web servers, database servers, application servers, and directory services.
- Infrastructure software is comprised of software tools that help keep the infrastructure running, including volume managers, file systems, management tools, and backup software.

The hardware infrastructure layer includes the following two elements.

- The storage platform includes host bus adapters (HBAs), Storage Area Network (SAN) switches, storage devices, and associated firmware.
- The computing platform consists of network interface cards (NICs), adapter cards, on-board service processors, and the server hardware

Network infrastructure and facilities infrastructure also represent important parts of the execution architecture. However, these elements are rarely a factor in regards to compatibility with the new

operating system version. In fact, for upgrade projects that include consolidation goals, the network and facilities infrastructure layers stand to benefit from a cost perspective. Consolidation projects generally reduce the number of systems in use, decreasing costs by minimizing the number of network ports necessary and lowering power and cooling requirements.

Whereas business needs generally dictate the number of software packages required at the business application layer, often there is room to reduce the variety of products in use within the application infrastructure, storage platform, and compute platform layers. For example, organizations can standardize on a few types of NICs, select one suite of management tools for use across all systems, or minimize the number of types and versions of Web servers deployed. As the compatibility assessment progresses, finding opportunities to reduce the number of products within these layers can dramatically reduce the workload and costs for current and future upgrade initiatives.

Completing a Software Inventory

Creating a software inventory for all servers that are a part of the upgrade project is the first step toward understanding the compatibility of the current execution architecture with the latest operating system release. For large projects, completing a software inventory can be one of the hardest parts of the assessment phase. However, creating the software inventory is necessary to understanding the state of the environment to be upgraded and is often very useful to other IT initiatives well beyond the scope of the upgrade project. To help this effort, many enterprises deploy a tool to monitor network traffic to identify applications and their dependencies.

Start the application inventory task by utilizing a software tracking tool or creating a small spreadsheet to record the following information for each piece of software on the target servers.

Software type: commercial, open source, custom

Product name and vendor

Current version in use: Supported on new OS version? If not, when?

Desired version: Supported on new OS version? If not, when?

Minimum version supported on new OS version

Changes to licensing model or costs for new versions

Application owner

Dependencies

Within complex environments, the software assessment may also need to include consideration for potential dependencies between software components. For example, changing the version of one software product may result in incompatibilities with other software programs on the same system. In these cases, the software inventory spreadsheet can include an additional column that notes these potential issues.

Checking Application Certification

The Oracle Solaris 10 Applications Library at http://www.sun.com/bigadmin/apps/ is an online tool that can be used to determine compatibility between specific application versions and Oracle Solaris 10. The interface for this tool accepts searches based on the software publisher's name or keywords that might be found in a product description and returns status information regarding support of this product on Oracle Solaris 10. To date, over 10,000 applications have been listed in this database as supporting Oracle Solaris 10.

The next step is to identify a plan of action to address gaps in support. The path taken to resolve compatibility issues for each piece of software depends on the priority of this software to the organization and the extent of its use. For applications that are not yet certified or available for Oracle Solaris 10, there are several choices:

Postpone the upgrade until the software is certified.

Move forward with a version of the application that is available for Oracle Solaris 10.

Explore the features within other software packages already in the environment that may be able to perform the same function. In the case of management tools, built-in features for some current tools may entirely replace older software.

Find an alternative piece of software to procure that performs the same function and is available for Oracle Solaris 10.

Host the application in an Oracle Solaris 8 or Oracle Solaris 9 Container running under Oracle Solaris 10. If the application currently runs under Oracle Solaris 8 or Oracle Solaris 9, it can be supported in an Oracle Solaris 8 or Oracle Solaris 9 Container. While this workaround may solve the problem, it should be a short term solution. The gap in the support matrix still remains and may increase in complexity over time. More information on Oracle Solaris 8 and Oracle Solaris 9 Containers is available at: *http://sun.com/software/solaris/containers/index.jsp*

As a final option, it is important to understand that the lack of certification for a particular application does not mean that the software can not run under Oracle Solaris 10. For some applications not listed in the Oracle Solaris 10 Applications Library — especially custom and open-source software — the Oracle Solaris Binary Compatibility Guarantee can help alleviate concerns. If an application runs on Oracle Solaris 2.6, 7, 8, or 9, it qualifies under the Oracle Solaris Binary Compatibility Guarantee to run on Oracle Solaris 10, even if it has not been recompiled for Oracle Solaris 10. If an application experiences compatibility problems when running on Oracle Solaris 10, Oracle can be engaged to analyze the problem and provide the appropriate remedy as set forth in the Oracle Solaris Binary Compatibility Guarantee Program Terms and Conditions[1].

When an application has not been officially certified by a software publisher or ISV, a contractual support problem may still exist. However, there are many situations where contract support is not required and the ability of the software to technically work within the environment is enough to move forward.

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[1] More information on the Oracle Solaris Binary Compatibility Guarantee Program is available at: *http://www.oracle.com/solaris*

Setting up a Test System

Once compatibility between important internal applications and Oracle Solaris 10 has been confirmed, the move to Oracle Solaris 10 can begin in earnest. Depending on the scope of the upgrade project, setting up one or more test systems might be useful at this point. The test systems can be loaded with key infrastructure and enabling software, serving as a tool for testing application performance, virtualization approaches, and any remaining application compatibility concerns, as well as providing a learning environment for system administrators getting started with Oracle Solaris 10.

Identifying Existing Hardware

Taking an inventory of the servers that are a part of the upgrade project is similar to the software inventory task. A tracking tool or simple spreadsheet can be used to store the information. Once this inventory is complete, it also can serve many additional purposes for data center planners and IT architects.

A hardware inventory is often easier to complete than the software inventory. For organizations that implement Information Technology Infrastructure Library (ITIL) concepts and practices, the information required for the hardware inventory likely exists in internal asset and configuration management databases. In cases where this information is not readily available, tools can help simplify the process of gathering system information. For example Sun Explorer is a free tool that facilitates data collection in an automated, consistent fashion. More information on installing and utilizing Sun Explorer is available at *http://docs.sun.com/app/docs/coll/1554.2*

Plan to gather the following items for the hardware inventory.

Sever model name

Location

Owner

Architecture (sun4u for example)

Hostname

Number of processors and speed

Memory and disk space

List of Sun and third-party adapter cards including HBAs and NICs

Type and model name of attached storage devices

If consolidation and virtualization are a part of the project plan, some measure of system compute capability must be documented as well as the current average and peak utilization levels. (If needed, contact local Oracle resources or Oracle partners for help with comparing the compute capacity of various server models.)

Although not absolutely necessary, including the function or role of a system within a solution, Domain Name System (DNS) information, and dependencies between systems can help create a more

complete understanding of the existing environment. Collecting these details also helps to make the document more valuable to other projects within the IT department.

Once the inventory is complete, perform the following steps:

Validate the system meets the minimum hardware requirements of Oracle Solaris 10 for memory and disk space. These specifications can be found at *http://oracle.com/solaris/*.

Check for potential compatibility issues. Information regarding the compatibility of each hardware component with Oracle Solaris 10 can be determined by utilizing the Web-based search tool at *http://sun.com/bigadmin/hcl/search.jsp*. During this step, be sure to check support for each component in the hardware inventory. Depending on the component, drivers may need to be downloaded from the hardware vendor.

Consider whether it is more advantageous to keep the existing hardware or replace it. Replacing the hardware offers an opportunity to lower maintenance costs and improve the environment in terms of efficiency. Utilizing new hardware may also reduce the level of effort required for the upgrade project. More information on this aspect is included in the "Deciding on the Hardware Platform" section. Consulting with local resources from Oracle or Oracle partners can also be helpful for confirming workload sizing estimates as well as gaining additional information regarding specific server models.

Considering IT Tools, Processes, and People

IT tools, processes, and people represent the functional management architecture of the enterprise infrastructure and are a critical part of the upgrade process. Given the extensive compatibility between previous versions of Oracle Solaris and Oracle Solaris 10, existing internal administrative scripts, procedures, and best practices developed for these versions often readily work in the new environment. However, there are differences, most notably in the area of service management. If an Oracle Solaris 10 test server is not already available, deploying a pilot system to test administrative scripts and best practices is advisable as part of the upgrade process. An extensive set of reference material helpful to working through any issues with utilizing current procedures and practices with Oracle Solaris 10 can be found at *http://sun.com/bigadmin/topics/upgrade/tools.jsp*.

As modifications are made within the enterprise infrastructure, IT staff must be made aware of all changes. Properly preparing people for the transition includes training key personnel on Oracle Solaris 10, process changes, and any new management tools that are introduced as a result of the upgrade. In addition, programs are needed to help ensure that necessary information about the new environment is efficiently disseminated to a broad range of IT staff members, including operations, help desk, system administrators, architects, and infrastructure planners.

Preparing the IT Tools, Processes, and People portion of the enterprise architecture for a transition varies for each individual enterprise. For complex situations or cases where the process needs to be expedited, Oracle can help by providing Oracle Solaris adoption and implementation services.

Architect the New Environment

Before beginning the actual upgrade, a few high-level architecture considerations should be taken into account. For example, an upgrade project is a good opportunity to evaluate the benefits of introducing a virtualization strategy, migrating to new server hardware, or modifying the data management strategy. This chapter discusses these key choices and their importance to optimizing project results.

Recognizing Virtualization and Consolidation Opportunities

The practice of deploying no more than one application per server often leads to a rapid increase in the number of servers to mange, low system utilization levels, and excessive operating costs. In many cases, server sprawl and horizontal scaling strategies have pushed data center power, cooling, and space resources to their limits. Virtualization technologies and consolidation strategies can help organizations create a more efficient environment with fewer servers to manage, lower operational costs, and better ROI.

Upgrade projects provide an excellent opportunity to recognize potential virtualization and consolidation opportunities. The software and hardware inventories alone can immediately shed light on obvious consolidation projects that can lead to significant cost reductions. For projects that already include plans to purchase new hardware for one application, it can be advantageous to consider selecting a server that can accommodate multiple existing workloads. In fact, the savings realized through consolidation are often enough to cover the cost of platform acquisition.

Oracle Solaris 10 provides built-in virtualization capabilities that can be used to modernize an organization's best practices for application hosting methodology. Oracle Solaris Containers offer organizations a no-cost solution that works on every server running Oracle Solaris. With Oracle Solaris Containers, many private execution environments can be created within a single instance of Oracle Solaris 10, allowing isolation of software applications and services using flexible, software-defined boundaries. Specific Sun servers from Oracle also offer virtualization capabilities. These hardware-based features are described in the following section of this document titled "Deciding on the Hardware Platform".

For more information on planning to virtualize or consolidate as a part of the upgrade process, please see *http://www.sun.com/bigadmin/topics/virtualization*. This Web site provides a detailed look at virtualization technologies and related benefits.

Deciding on the Hardware Platform

Deciding between retaining the current server platform or migrating to new hardware is the first key choice before starting the actual upgrade. This selection must be made for each server targeted within the project. As the decisions are completed, the hardware inventory created in the last step can be annotated to include this information.

Retaining the current server platform can help minimize project costs. However, this method does imply at least some nominal amount of downtime for the transition. In addition, organizations should

consider the following questions before proceeding:

Does the current platform offer sufficient headroom to continue supporting this application for a reasonable length of time into the future?

Is this platform viable from a support standpoint for the next year or more, or is it reaching obsolescence?

Can this workload be consolidated onto other existing systems that are also being upgraded to Oracle Solaris 10? Are there potential savings that can be realized by choosing a consolidation approach?

Are there multiple workloads that can be consolidated onto a new system and can the savings realized through consolidation help mitigate the cost of platform acquisition? Cost savings might be realized by reducing maintenance contract, software licensing, energy, space, and administrative expenses.

How do the support costs of the existing platform compare to more current server models?

For cases where a decision has been made to utilize a new platform for the upgrade to Oracle Solaris 10, choosing the actual server model involves carefully matching the application workload to the platform characteristics. Oracle's portfolio of server products includes Sun SPARC Enterprise M-Series servers, Sun SPARC Enterprise T-Series servers, and Sun x86 servers. With the exception of device drivers, loadable modules, and firmware that enable certain platform-specific capabilities, the feature set of the Oracle Solaris 10 distribution is identical across each of these architectures. Therefore, there is no need to make any trade-offs in regard to the abilities of Oracle Solaris 10 on each type of platform.

Choosing a platform to host a particular workload can be based on the characteristics and strengths of the server architecture. At a high-level, the different categories of systems available from Sun can be described as follows:

Oracle's Sun SPARC Enterprise M-Series servers powered by SPARC64® processors offer maximum reliability, availability, and serviceability as well as massive vertical scalability. Servers in this product family range in size from a single processor quad-core system to a platform that supports up to 64 processors, 256 cores, and 512 virtual processors. Sun SPARC Enterprise M-Series servers also provide a built-in virtualization capability known as Dynamic Domains. With this technology, administrators can partition a system along hardware boundaries into Dynamic Domains that are electrically fault-isolated from one another. Dynamic Domains allow a single Sun SPARC Enterprise M-Series server to run multiple instances of Oracle Solaris. To maximize flexibility, Dynamic Reconfiguration enables administrators to dynamically reconfigure, remove, or install core system components in a Dynamic Domain while Oracle Solaris and hosted applications continue to run. Mission-critical workloads, large single instance databases, and consolidation projects are good examples of workloads that may benefit from Oracle's Sun SPARC Enterprise M-Series servers.

Oracle's Sun SPARC Enterprise T-Series servers are environmentally efficient servers that utilize UltraSPARC® T2 and UltraSPARC T2 Plus processors to deliver superior performance and provide built-in virtualization capabilities. At the high-end of this server line, these systems support up to four processors with eight cores per processor for a total maximum of 256 threads in a single server. Oracle VM Server for SPARC (formerly Sun Logical Domains) is built into these systems to allow

the partitioning of hardware resources, including individual CPU threads, for complete isolation between operating system instances. Applications with a high degree of parallelism — such as Web servers and databases — that generate a large number of threads and prioritize throughput in terms of transactions per second are a good match with the capabilities of these servers.

Oracle's Sun x86 servers include platforms with Intel® Xeon® or AMD Opteron™ processors. Systems in the Sun x86 server product line support up to eight processors with up to six cores per processor. These platforms maximize flexibility and investment protection with the ability to run Oracle Solaris, Microsoft Windows, and Linux operating systems. Applications with a minimal number of threads, a reliance on horizontal scalability, and an emphasis on clock speed or fast response times in terms of transaction rates are ideal workloads to host on Oracle's Sun x86 servers.

Understanding Data Migration Requirements

Data migration considerations are generally minimal for upgrade projects that plan to retain the same storage devices and interfaces currently in use. Before the upgrade occurs, data volumes must be properly exported. Post-upgrade, most volume management tools offer features that support the simple import of the same data to the new platform — even if the hostid or server name have changed. Precise steps vary based on the volume manager and file system tools in use and exceed the scope of this paper.

As a part of an upgrade project, IT organizations also can plan to improve the environment by taking advantage of data storage technology within Oracle Solaris 10. For example, Oracle Solaris (ZFS) is a 128-bit file system that provides 16 billion, billion times the capacity of 32-bit or even 64-bit file systems. The superior file system capabilities of Oracle Solaris ZFS can help automate common administrative tasks and protect data from corruption. Oracle Solaris ZFS does not require a volume manager and uses virtual storage pools to make it easy to expand or contract file systems, streamlining storage administration and allowing resources to be more easily shared. In addition, Oracle Solaris ZFS protects data with 256-bit checksums, resulting in exceptional error detection and correction. More detailed information about deploying Oracle Solaris ZFS can be found at *http://www.sun.com/bigadmin/topics/zfs*.

There are some extra steps for projects that decide to change the file system or volume manager infrastructure software. In these cases, data may need to be rewritten to the devices after the new file system or volume manager is in place. This can be accomplished by writing a backup copy of the data out to the newly formatted device. Alternatively, the server can be set up to accommodate the existing storage infrastructure in addition to a new set of storage devices. With both new and existing storage devices attached, data can be copied between the storage arrays. Aside from the obvious expense, this can be a complex scenario since it may involve supporting two volume managers at the same time. It is important to consider any potential impact data migration may have on business operations. The process of copying data can degrade application performance and it may be advisable to schedule the data transfer for a period of regularly scheduled downtime.

Execute the Upgrade

The installation program included with an Oracle Solaris 10 distribution includes the ability to upgrade a system from Oracle Solaris 8 or Oracle Solaris 9 using step-by-step point-and-click procedures. Performing a manual upgrade as a proof-of-concept is a good idea for improving system administrator familiarity and comfort with Oracle Solaris 10. However, for upgrade projects consisting of more than a few servers, manually executing these steps is generally too labor intensive and time consuming. Using tools, such as Oracle Solaris Flash archive technology, Oracle Solaris JumpStart software, and Oracle Solaris Live Upgrade software, can help automate the upgrade process and minimize the manual effort required for installation of operating system packages, patches, and application infrastructure software. (Detailed instructions for upgrading to Oracle Solaris 10 utilizing the distribution CDs, Oracle Solaris JumpStart software, or Oracle Solaris Flash technology can be found in the documents at *http://docs.sun.com/app/docs/coll/1236.11*). Perhaps more importantly, utilizing these tools can promote standardization of the operating system configurations within in an environment, thereby simplifying system administration and potentially improving service levels.

Utilizing Oracle Solaris Flash Archive Technology

Oracle Solaris Flash archive technology supports the creation of master images that are snapshots of existing systems. The images, called Oracle Solaris Flash archives (FLARs), can include the operating system, patches, and application software. Once created, a Oracle Solaris Flash archive can be quickly and easily deployed to any server in the environment with an identical processor architecture. In fact, internal tests conducted at Oracle have shown that a complete Web server can be set up using the network install feature of Oracle Solaris Flash software in under three minutes.

Defining the Required Master Operating System Images

Servers of the same processor architecture can use the same Oracle Solaris Flash archive image even if they are different server models. For example, Oracle's Sun Enterprise 250 server can use the same Oracle Solaris Flash archive image as the much larger Sun Fire 25K server from Oracle — they are both based on the sun4u architecture built on the UltraSPARC processor. Therefore, the number of different server architectures present within the set of servers to be upgraded determines the minimum number of master operating system images that must be created.

Standardizing operating system images to one per hardware architecture helps streamline the environment. However, some organizations choose to create many more operating system images to accommodate variations in the number and types of Oracle Solaris 10 packages to include. For example, organizations with a set of servers with high security requirements often create a Solaris Flash archive that includes only a minimal number of Oracle Solaris packages. Items such as network protocols, binaries, and services that are non-essential to executing the specific workload are stripped out. In addition, organizations that use a variety of Oracle or third-party file systems, volume managers, and monitoring tools may elect to load these tools on some systems and not others. If it becomes apparent that more than a handful of master operating system images are required for a particular environment, an upgrade project is actually an excellent opportunity to reduce variations. Taking steps

toward standardization of the operating system images in use can significantly reduce cost and complexity within the execution architecture.

Considering the variances across the enterprise related to the following items can help identify the number of master images required for a particular environment:

Server architecture types

Specific operating system packages or clusters to include or omit

Infrastructure software to include in the master image

Enabling software such as Web and application servers that may be used widely enough to be built into a master image

Hardware interface, storage, and peripheral device drivers

Patch levels

Creating an Oracle Solaris Flash Archive

Creating an Oracle Solaris Flash archive involves installing and configuring Oracle Solaris 10 on an available server and adding necessary patches, device drivers, and applications as defined for this master image. As a part of post-installation clean-up, certain environments may require specific operating system packages to be removed and other operating system configuration files to be added. Figure 2 shows the steps for configuring a server and then creating and saving a Oracle Solaris Flash archive for replication. The end result is a system image — fully customized to match the needs of a specific data center environment — that can be quickly and easily replicated on other servers using either Oracle Solaris JumpStart software or Oracle Solaris Live Upgrade software.

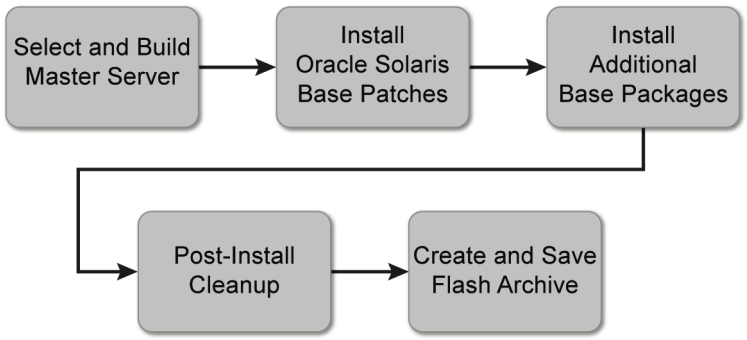

Figure 2. Steps for creating a master installation image using Oracle Solaris Flash archive technology

Upgrading to Oracle Solaris 10 with Hardware Replacement

Oracle Solaris JumpStart software is most often chosen for installation processes when an upgrade project involves the deployment of a replacement server, use of a new hard disk drive for the boot disk, or the freedom to overwrite the existing boot device. In addition to fresh operating system installs, Oracle Solaris Jumpstart software can support operating system upgrades. However, Oracle

Solaris Jumpstart software lacks some important capabilities offered by the Oracle Solaris Live Upgrade software. Specifically, Oracle Solaris Jumpstart software does not support the ability to continue running on the current operating system while an alternate boot disk or disk partition with the new operating system is loading.

An environment for Oracle Solaris JumpStart software includes a central server that stores the installation images of various versions of Oracle Solaris. Utilizing an Oracle Solaris Flash archive in conjunction with Oracle Solaris JumpStart software offers an efficient installation. However, projects that lack the resources to create Oracle Solaris Flash archive images can still use Oracle Solaris Jumpstart software with a standard Oracle Solaris 10 distribution image to automate the installation process.

Configuring an Oracle Solaris JumpStart Software Infrastructure

An Oracle Solaris Jumpstart software infrastructure is comprised of the following components:

Install Client — the target system to be installed or upgraded.

Boot Server — a network boot mechanism that provides a failsafe method of booting the install client. The boot image is architecture independent, providing basic operating system services to all hardware supported by that operating system release. The Boot Server provides Reverse Address Resolution Protocol (RARP), Trivial File Transfer Protocol (TFTP), and bootparam services.

Configuration Server — a system that stores unique profile information for various installation types. Partition sizes, lists of software components to install, and other operating system installation details are specified in a profile served by the Configuration Server. Optional pre-installation and post-installation scripts — also known as begin and finish scripts — can help customize the installation and are also loaded on this system. All files are shared to the client utilizing the NFS protocol.

Install Server — the source of the software packages to be installed on the client. The Oracle Solaris distribution must be loaded into a NFS-shared directory on this server.

Keep in mind that these Oracle Solaris JumpStart software infrastructure components are functional descriptions. In fact, the boot, configuration, and install server functions can be consolidated onto a single physical system.

To prepare to utilize Oracle Solaris JumpStart software for the first time, an administrator must perform the steps shown in Figure 3. These steps include configuring the boot server, loading the Oracle Solaris 10 distribution or FLAR image on the install server, creating and verifying the configuration files, sharing the installation directories via NFS, and configuring access to the Solaris JumpStart software services for each install client. Once a Oracle Solaris JumpStart server environment has been established, only one step— configuring client access — is required to add new install clients. Configuring client access is as simple as adding the server to the */etc/hosts* file and executing the Oracle Solaris Jumpstart *add_install_client* script.

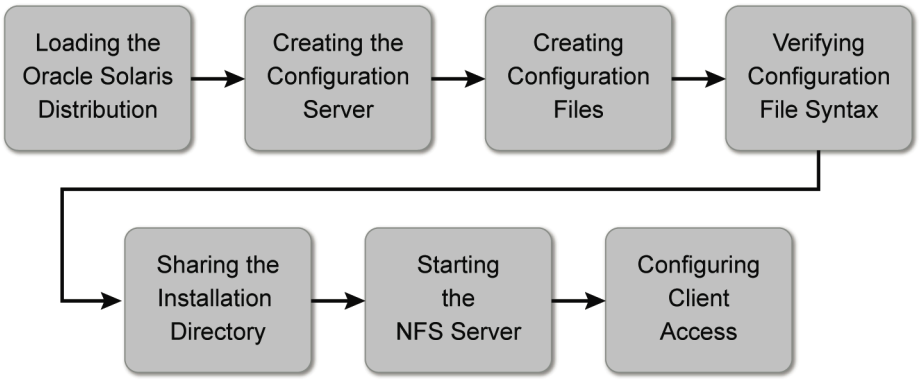

Figure 3. The initial configuration of a JumpStart software infrastructure involves a number of steps.

Once the JumpStart software infrastructure is established, provisioning a server follows these basic steps:

Boot Install Client: Oracle servers with SPARC® processors can be booted for Oracle Solaris Jumpstart software installation by issuing a simple "boot net - install" command at the OpenBoot OK prompt. Servers with x86 processors can utilize a Preboot eXecution Environment (PXE) to boot the client. Both methods bootstrap the install client with the operating system kernel and load installation-specific data.

PXE is common within data center environments that support x86 and x64 servers. This technology supports the ability for new x86 and x64 client systems to enter a heterogeneous network, acquire a network address from a Dynamic Host Configuration Protocol (DHCP) server, download a bootstrap program, and begin installation. For more information on PXE, please see the specification at: *http://intel.com/design/archives/wfm/downloads/pxespec.htm*

Begin Script Executes: A script executes to complete any tasks required prior to the actual operating system installation, such as setting permissions on files or directories.

Operating System Installation: The Oracle Solaris installation image or Oracle Solaris Flash archive on the install server is provisioned on the install client.

Finish Script Executes: Although optional, this script is commonly utilized to install operating system patches that have been released since the date of the operating system distribution. In addition, the Oracle Solaris JumpStart software finish script can be utilized to install Oracle and third-party software. The script can include commands to remotely mount the software distribution or transfer the necessary files onto the client as well as execute the custom commands required to perform the application installation.

Reboot Install Client: As is normal for any operating system installation, the install client reboots after the completion of the full installation. Once the reboot completes, the install client is ready for installation of any additional required application software.

Step-by-step detailed command line instructions for creating a Oracle Solaris JumpStart software server configuration for provisioning x64 and x86 systems can be found in Configuring JumpStart Servers to

Provision Sun x86-64 Systems at *http://sun.com/blueprints/0205/819-1692.pdf*

Minimizing Service Interruption for Upgrades that Utilize Existing Hardware

A good upgrade project includes plans for minimizing downtime and offers a dependable fallback mechanism. For projects that plan to migrate to new hardware, the transition often is simple. The existing server can continue to support the application workload until the new system is completely staged and tested. A switch to the new system can occur instantaneously and the old server functions as a fallback mechanism. With the help of Oracle Solaris Live Upgrade software, even projects that intend to retain the existing hardware often can limit application downtime to a simple reboot and maintain a solid fallback mechanism.

Oracle Solaris Live Upgrade software allows an existing operating system environment to continue running while a new disk is being provisioned. This process essentially creates two boot environments — the current boot environment and a new or alternate boot environment with Oracle Solaris 10. Utilizing Oracle Solaris Live Upgrade software to maintain two boot environments helps organizations keep a known working environment readily available as a fallback position. In the event of an urgent problem, an administrator can quickly revert to the old environment. With the possible exception of the most mission-critical applications, this method generally eliminates the need to create a separate test server.

In many cases, servers already have a disk configuration that includes a mirrored system disk for higher availability. A mirrored configuration offers an opportunity to minimize service interruptions by temporarily utilizing the mirror system disk as an alternate boot disk. With disk mirroring temporarily turned off, the mirrored disk can be upgraded to Oracle Solaris 10 while operations continue on the primary disk device. This scenario is illustrated in Figure 4.

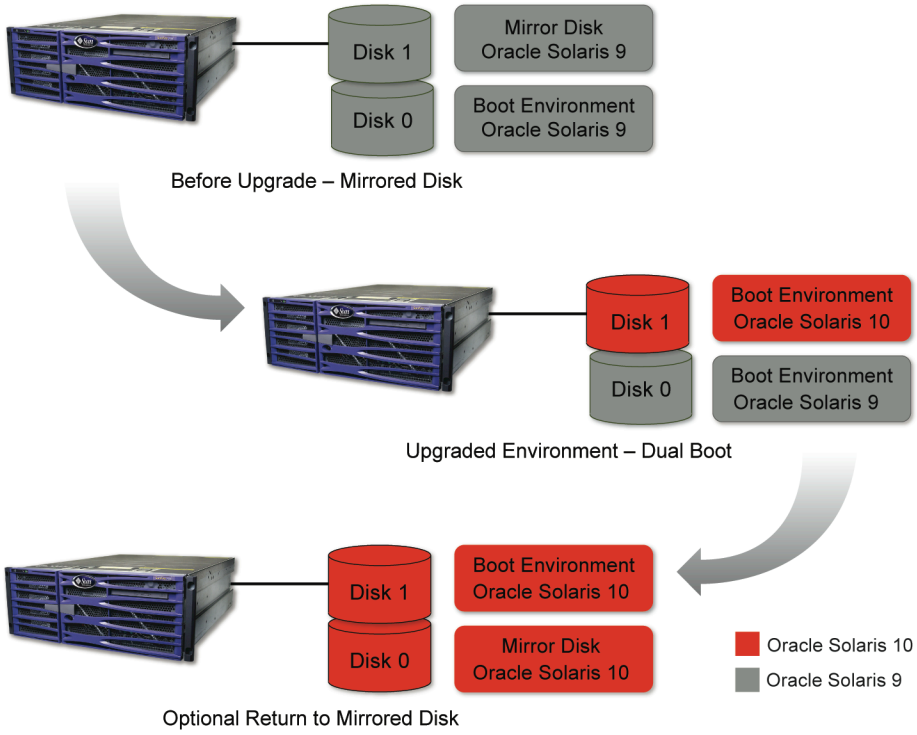

Figure 4. Solaris Live Upgrade software can help organization switch between two versions of the operating system via a simple reboot.

This approach saves the time and cost of adding an extra disk to the server during the upgrade process. However, this benefit must be weighed against the risk associated with turning off disk mirroring during the upgrade process. For situations where a mirror disk is not available, another means must be used to provide the alternate boot disk. In some cases it may be necessary to add an extra disk to the system that can serve as the alternate boot disk.

After the upgrade is complete, the dual boot environment can be maintained to provide a fallback mechanism for as long as desired. When the fallback mechanism is no longer needed, the old boot disk can be returned to its original purpose. If it was originally a mirror disk for the old operating system environment, it can be re-established as a mirror disk for the new Oracle Solaris 10 boot disk to add redundancy.

Utilizing a Dual Boot Strategy to Help Support Legacy Applications

A dual-boot strategy can also be used as a part of a support model for legacy applications that are supported on an older version of Oracle Solaris and are not certified for Oracle Solaris 10. After installing Oracle Solaris 10 on the primary boot disk, create an alternate boot environment that complies with the application support requirements. The alternate, supported boot environment can be used for troubleshooting purposes into the future.

When problems arise, testing can be performed under both boot environments to easily determine if the issue is related to the application or the use of Oracle Solaris 10. If it is an application issue, a

vendor-supplied patch can be verified under the supported operating system version and then promoted to the Oracle Solaris 10 boot environment. If use of Oracle Solaris 10 seems to be causing the issue, Oracle can be contacted for support, citing the Oracle Solaris Binary Compatibility Guarantee.

Preparing for the Upgrade

Before starting the upgrade, the server targeted for the upgrade must be configured to meet the minimum requirements for the Oracle Solaris 10 upgrade process. This step includes the following actions:

Check for installation of required packages and patches (e.g. Oracle Solaris Live Upgrade software).

- To determine the necessary patches required by a system, read Sun Infodoc ID72099, Oracle Solaris Live-Upgrade Minimum Patch Requirements.
- Oracle Solaris Live Upgrade software also requires a set of prerequisite packages as detailed by the chart in the Oracle Solaris Live Upgrade Guide at http://docs.sun.com/app/docs/doc/817-5505.
- Once the prerequisite packages are in place, the Oracle Solaris Live Upgrade software packages, SUNWlur and SUNWluu, must also be installed from the version of Oracle Solaris to which the target machine is being upgraded. For example, if the machine is being upgraded from Oracle Solaris 8 to Oracle Solaris 10 10/09, the Oracle Solaris Live Upgrade software packages must be installed from the Oracle Solaris 10 10/09 distribution.

Install packages and patches as necessary.

Break the mirror of the operating system disk if plans include using the mirror disk as an alternate boot device.

Partition the new operating system disk as appropriate to the specific environment. For example, create partitions for /, /usr, /var, and /opt.

Initiating the Live Upgrade

With the disk partitions already in place for the new environment, initiate the upgrade by specifying the location of the current boot environment and upgrade the boot environment using Oracle Solaris Live Upgrade software commands. Oracle Solaris Live Upgrade software can access the necessary installation files from either a CD-ROM, network mounted image of the Oracle Solaris distribution, or Oracle Solaris Flash archive. The location of the media image to use is specified in the Oracle Solaris Live Upgrade software command line parameters.

Once the Oracle Solaris Live Upgrade software commands complete, the final step is to manually activate the alternate boot environment (Oracle Solaris 10) and reboot the server. Oracle Solaris Live Upgrade software synchronizes some additional system files when the boot environment is activated and the server reboots. Although the Oracle Solaris Live Upgrade software allows the server to continue operating during the installation process, this final step requires some downtime. The amount of downtime is generally limited to only the time required for the reboot of the server. Because this

step can impact the user community, this final part of the upgrade process should be scheduled in advance to minimize the impact to users.

Rolling Back the Upgrade

When the upgrade process is completed under the Oracle Solaris Live Upgrade software, the server contains a dual-boot environment in which Oracle Solaris 10 is the primary boot drive and the previous operating system release is available as an alternate boot drive. This dual-boot configuration can remain in place as long as desirable. A waiting period, typically for 15 to 30 days, is a typical time frame for customers to observe the applications as they work in the new operating system. If the waiting period is observed without any reported incidents, administrators can be relatively comfortable that the new operating system environment is working well and that the old operating system environment can be removed.

To remove the alternate boot environment, the administrator can simply re-purpose the alternate boot disk. If a disk mirror had been in place prior to the upgrade, the administrator can re-establish this redundancy by turning the alternate boot disk into a mirror disk for the Oracle Solaris 10 installation. Alternatively, the old boot environment can simply be brought back into the pool of available storage for user and application data.

Testing the Implementation

Given that Oracle Solaris 10 supports binary compatibility for applications that run on previous versions of Oracle Solaris, application testing can generally be kept to a minimum. Because of the safety offered by the fallback mechanism in the dual boot environment, non-mission-critical applications can be moved to the Oracle Solaris 10 environment and assumed to work unless a problem is reported by users. While there is some obvious risk in this approach, Oracle's experience has been that most applications do indeed run without incident.

All applications that comply with the Oracle Solaris Application Binary Interface (ABI) should run without modification when moved to a later version of Oracle Solaris. Most often, the exception to this rule is an application or script that looks for a particular system attribute such as the IP address or OS version. (eg: if (Oracle Solaris 8) run, else exit();). These applications are readily identifiable and the problem can be easily resolved.

Mission-critical applications can be tested using existing test processes within the organization. This usually involves a test system that is already in place and test procedures that are designed for testing new releases of the software before they are put into production. In these environments, Oracle Solaris 10 can be introduced on the test configuration using the same procedures as for non-mission-critical applications including the use of a temporary dual boot environment. Once the software has been fully tested on Oracle Solaris 10, it can be moved into production. The dual boot environment can then be used in the production environment for as long as desired.

Take Full Advantage of Oracle Solaris 10

Certain benefits can be immediately realized by simply upgrading from Oracle Solaris 8 or Oracle Solaris 9 to Oracle Solaris 10 — even without taking actions to specifically utilize any new features. Application performance is a prime example. An enhanced TCP/IP stack, improved kernel, and special optimizations for memory allocation and chip multithreading technology can help organizations gain faster performance for a broad range of workloads without requiring changes to existing applications.

Despite the ability to utilize Oracle Solaris 10 in a manner similar to previous releases of the Oracle Solaris and still gain benefits, a number of features within Oracle Solaris 10 can help radically improve the IT environment. Taking advantage of the capabilities of Oracle Solaris 10 can help organizations with efforts to increase the reliability of IT services, further optimize system performance, maximize IT asset utilization, and improve overall security. A detailed listing that compares the capabilities of Oracle Solaris 10 to previous versions of Oracle Solaris can be found at:
http://sun.com/software/solaris/whats_new.jsp

Improve IT Service Uptime with the Service Management Facility

While many of the new capabilities introduced in Oracle Solaris 10 are transparent and impose no mandatory change to existing practices, the Oracle Solaris Service Management Facility (SMF) is one area of adoption of Oracle Solaris 10 that requires some attention to change. UNIX® software has traditionally set management to reside at the process level. Most complex services, such as NFS, identity, print, name services, file system, are multiprocess in nature, requiring the service writer to create custom management tools for starting, stopping, and monitoring the executable. Under this model, system administrators must learn unique procedures for managing each service. SMF allows services to become managed entities instead of the individual processes. With the introduction of SMF, system administrators can now view system-wide service status, access information about misconfigured or misbehaving services, and enable and disable services persistently across upgrades and patches.

SMF is designed to simplify the management of system and application services. It delivers new and improved ways to control services, and tries to restart failed services automatically. In addition, SMF allows administrators to define the relationships between services. It is now possible to define a service that is dependent on other services — a dependent service will not run unless the other services that it requires are already running. Through a set of new administrative interfaces, SMF allows services to be easily and consistently configured, enabled, and controlled, at the same time providing better visibility of errors and improved debugging capabilities to resolve service-related problems quickly when they occur.

SMF offers many advantages, including:

Simplified service administration. Services are objects that can be viewed and easily managed with a few simple administrative commands.

Automated restart of failed services. SMF monitors service processes, and can proactively restart a service when it detects an administrative error, hardware fault, or service death.

Persistent service configuration. Service definitions and configurations persist across reboots, even after installing OS upgrades or patches.

Explicit dependencies. Relationships are defined between services to reflect that some services rely on the availability of other services.

Easier debugging. Individual service log files make it easier to determine why a service is not running.

Faster boot and shutdown processes. SMF parallelizes the starting and stopping of services when possible.

Delegated service administration. Administrators can securely delegate service-related tasks to non-root users, including the ability to configure, start, stop, or restart services.

For more information about SMF, please see *http://www.sun.com/bigadmin/content/selfheal/smf-quickstart.jsp*. The article provides a quick start guide to understanding the power of SMF. Examples in the article show how to administer services, perform common administrative tasks, and administer network services using SMF commands.

Maximize Use of IT Assets with Oracle Solaris Containers

Oracle Solaris Containers provide a means for creating virtualized operating system environments within a single instance of Oracle Solaris. With this technology, organizations can isolate and manage multiple applications on the same server to reduce costs and complexity. Oracle Solaris Containers can be used to effectively deploy hosting facilities, consolidate multiple database instances, consolidate development and test environments, stage applications, and consolidate Web services systems.

Oracle Solaris Containers are designed to provide fine-grained control over the resources that applications use, allowing multiple applications to operate on a single server while maintaining specified quality-of-service (QoS) levels. Fixed resources such as processors and memory can be partitioned into pools on multiprocessor systems, with different pools shared by different projects (a specified collection of processes) and isolated application environments. Dynamic resource sharing allows different projects to be assigned different ratios of system resources.

When resources such as CPUs and memory are dynamically allocated, resource capping controls can be used to set limits on the amount of resources used by a project. With all of these resource management capabilities, organizations can consolidate many applications onto one server, helping to reduce operational and administrative costs while increasing availability.

In addition to Oracle Solaris Containers technology in Oracle Solaris 10, Oracle also offers Oracle Solaris 8 and Oracle Solaris 9 Containers software. This software serves as a valuable transition tool, allowing applications for Oracle Solaris 8 or Oracle Solaris 9 to run in a Container on Oracle Solaris 10 and the latest server hardware.

Increase Performance with the Power of Dynamic Tracing

Many system performance problems are difficult to diagnose and reproduce. Even given high levels of system expertise and considerable testing time, many of these problems are never satisfactorily

resolved. Oracle Solaris 10 improves the way system administrators and developers identify the reasons for suboptimal system and application performance.

Oracle Solaris Dynamic Tracing (DTrace) technology makes it possible to delve deeply into complex systems to troubleshoot systemic problems in real time. With Oracle Solaris DTrace, administrators, integrators, and developers can tune applications for performance and troubleshoot production systems — with little or no performance impact. For more information on Oracle Solaris DTrace please visit *http://sun.com/bigadmin/content/dtrace*, or read the Solaris Dynamic Tracing Guide at: *http://docs.sun.com/app/docs/doc/817-6223*.

Create a More Secure Business Environment

Based on a long-standing commitment to supporting high levels of platform security, Oracle Solaris 10 includes extensive security capabilities. Many of these features start protecting the environment without the need for any specific configuration steps or process changes. For example, Oracle Solaris 10 binaries are digitally signed, allowing administrators to track changes easily. Patches and enhancements are embedded with digital signatures, eliminating the false positives associated with upgrading or patching file integrity checking software. Oracle Solaris 10 also provides the Basic Audit and Reporting Tool (BART) for integrity checking of files.

Organizations can choose to further fortify the new environment by taking advantage of the following capabilities of Oracle Solaris 10:

User and process rights management. Oracle Solaris 10 offers unique User and Process Rights Management technology to reduce risks by granting users and applications only the minimum capabilities needed to perform their duties.

Network service protection. Oracle Solaris 10 provides protection against inappropriate use of network resources through its Secure By Default networking configuration, which disables many unused network services to reduce exposure to attack. With Secure by Default, an administrator can enable or disable individual network services or change how they listen for network connections.

Cryptographic services and encrypted communication. For high-performance, system-wide cryptographic routines, the Oracle Solaris Cryptographic Framework adds a standards-based, common API that provides a single point of administration for cryptographic routines and digital certificate lifecycle management. Oracle Solaris 10 also provides protection against theft of sensitive material by encrypting communications using Oracle Solaris Internet Protocol Security (IPsec)/Internet Key Exchange (IKE) and Solaris Secure Shell protocols.

Mandatory access control, labeling, and security certification. Oracle Solaris trusted extensions solve the problem of controlling access to sensitive data by implementing sensitivity labels for access control to files, printers, networks, windows, applications, and devices. Oracle Solaris 10 with trusted extensions is the only labeled OS feature to support full enterprise-class solutions, giving customers multilevel desktops through the GNOME-based Java Desktop System or CDE, simple deployment, and centralized user ID management. Oracle Solaris 10 11/06 is currently in evaluation at EAL4+, one of the highest levels of Common Criteria Certification, with three Protection Profiles: Labeled

Security Protection Profile (LSPP), Controlled Access Protection Profile (CAPP), and Role-Based Access Control Protection Profile (RBACPP). In addition, Oracle Solaris 10 3/05 has completed evaluation at EAL4+ with CAPP and RBACPP.

Summary

Adopting Oracle Solaris 10 can help organizations realize increases in application performance, data center efficiency, reliability, and security. Unfortunately, many companies procrastinate the move to Oracle Solaris 10 based on the potential for risk. With the right approach, upgrade projects involve minimal risk exposure and far more potential for reward.

As described, proper planning and the use of scalable processes can simplify the move, minimize disruption during the upgrade, and help ensure success. For example, taking the time for a simple assessment of the compatibility of the existing environment with Oracle Solaris 10 can reduce the risk of operating system upgrade projects right from the start. During the actual upgrade, offerings from Oracle, including Oracle Solaris Flash archive technology, Oracle Solaris JumpStart software, and Oracle Solaris Live Upgrade software, provide scalable methods that minimize the opportunity for error and overall effort required.

To realize the greatest gain, organizations can consider virtualization and consolidation opportunities or the adoption of new hardware or data management techniques as a part of the upgrade initiative. Post-upgrade, Oracle Solaris 10 offers dozens of new capabilities to further improve the environment going forward. As many organizations have already realized, taking the time to modernize the environment through an Oracle Solaris 10 upgrade project can lead to greater performance, operational efficiency, and significant cost savings.

For More Information

For more information on the Oracle Solaris 10 upgrade process and related topics please see the references listed in Table 1.

TABLE 1. REFERENCES FOR MORE INFORMATION

WEB SITES	
Solaris 10 Upgrade Resources for System Administrators	http://bigadmin.com/topics/upgrade
Oracle Solaris Operating System	http://www.oracle.com/us/products/servers-storage/solaris
Solaris 10 Applications Library	http://sun.com/bigadmin/apps
Solaris 10 Hardware Compatibility	http://sun.com/bigadmin/hcl/search.jsp

Sun CMT servers	http://oracle.com/us/products/servers-storage/servers/sparc-enterprise/cmt-servers
Oracle Sun SPARC Enterprise servers	http://www.oracle.com/us/products/servers-storage/servers/sparc-enterprise
Sun x64 Servers	http://www.oracle.com/us/products/servers-storage/servers/x64
Sun Support Center	http://www.sun.com/support/
WHITE PAPERS	
Create a More Effective Enterprise, Adopt the Solaris 10 Operating System	http://www.sun.com/tradeins/docs/adopt_solaris.pdf
Best Practices for Moving to the Solaris 10 Operating System	http://developers.sun.com/solaris/docs/s10-adoption-bp1-041910-1.pdf
Migrating to the Solaris Operating System	http://wikis.sun.com/display/BluePrints/(Book)+Migrating+to+the+Solaris+Operating+System
Maintaining Solaris with Live Upgrade and Update on Attach	http://wikis.sun.com/display/BluePrints/Maintaining+Solaris+with+Live+Upgrade+and+Update+On+Attach
Patching Mirrored Systems with the Solaris Live Upgrade Software	http://wikis.sun.com/display/BluePrints/Patching+Mirrored+Systems+with+the+Solaris+Live+Upgrade+Software
Configuring JumpStart Servers to Provision Sun x86-64 Systems	http://sun.com/blueprints/0205/819-1692.pdf
Building a Bootable DVD to Deploy a Solaris Flash Archive	http://wikis.sun.com/display/BluePrints/Building+a+Bootable+DVD+to+Deploy+a+Solaris+Flash+Archive
Solaris Containers - What They Are and How to Use Them	http://wikis.sun.com/display/BluePrints/Solaris+Containers--What+They+Are+and+How+to+Use+Them
The Sun BluePrints Guide to Solaris Containers - Virtualization of the Solaris Operating System	http://wikis.sun.com/display/BluePrints/The+Sun+BluePrints+Guide+to+Solaris+Containers-+Virtualization+in+the+Solaris+Operating+System
Working with Solaris Containers and the Solaris Service Manager	http://wikis.sun.com/display/BluePrints/Working+with+Solaris+Containers+and+the+Solaris+Service+Manager
Service Management Facility in the Solaris 10 OS	http://wikis.sun.com/display/BluePrints/Service+Management+Facility+(SMF)+in+the+Solaris+10+OS
TRAINING	
Oracle University Sun Training	http://education.oracle.com
MANUALS	
Solaris 10 10/09 Release and Installation	http://docs.sun.com/app/docs/coll/1236.11

Collection	
Solaris 10 System Administrator Collection	http://docs.sun.com/app/docs/coll/47.16
Solaris 8 Containers Collection	http://docs.sun.com/app/docs/coll/1759.1
Solaris 9 Containers Collection	http://docs.sun.com/app/docs/coll/1820.1
BOOKS	
Migrating to the Solaris Operating System—The Discipline of UNIX-to-UNIX Migrations	http://wikis.sun.com/display/BluePrints/(Book)+Migrating+to+the+Solaris+Operating+System
JumpStart Technology	http://wikis.sun.com/display/BluePrints/(Book)+JumpStart+Technology
Solaris 10 System Administration Essentials	http://sun.com/books
Solaris 10 Security Essentials	http://sun.com/books
Solaris 10 ZFS Essentials	http://sun.com/books
Solaris Performance and Tools: DTrace and MDB Techniques for Solaris 10 and OpenSolaris	http://sun.com/books

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Brian Down serves as a Chief Technologist at Oracle. He is also the author of Protecting Investments Through Technology Advancements and co-author of Migrating to the Solaris Operating System: The Discipline of Unix-to-Unix Migrations. Brian is currently the Board Chair for the Consortium for Software Engineering Research (CSER) and is a board member of the Optical Research Advanced Network for Ontario (ORANO).

Acknowledgments

The author gratefully acknowledges the contributions to this technical white paper provided by the following individuals: Scott Dickson, Ambreesh Khanna, Jeff Savit, and Ken Pepple.

Oracle is committed to developing practices and products that help protect the environment

Moving to Oracle Solaris 10
April 2010
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