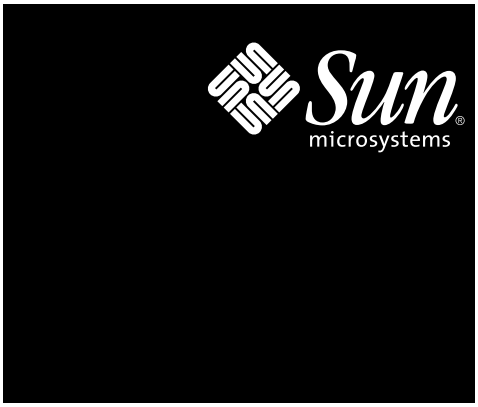
Provisioning and Change Management Tools

A Technical White Paper



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Chapter 1

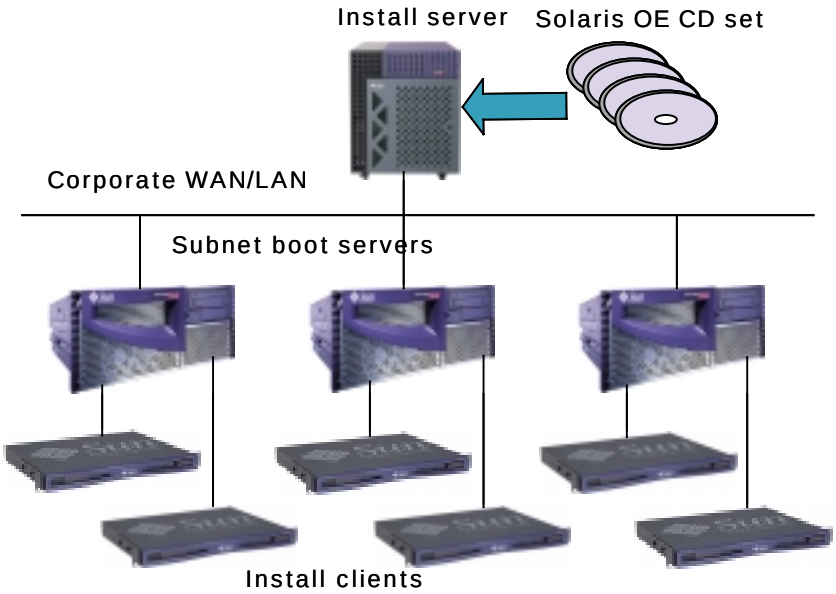
Introduction

Running a business in a networked world and delivering services-on-demand requires managing systems with the predictability of a data center and the agility of the Internet. Providing high levels of availability while quickly responding to change are now prerequisites for increasing profitability and retaining a competitive edge. Sun understands these needs and is continually developing applications and tools to help IT managers and administrators meet the goals of lowering Total Cost of Ownership (TCO) while simplifying the processes involved.

Installing and maintaining software — operating systems, applications, and patches — are some of the most time-consuming and error-prone tasks facing system administrators today. Installing large numbers of similar servers can be complex, inconsistent, and inefficient. Upgrading and patching software can typically require hours of planned downtime, as well as unplanned downtime if the upgrade fails.

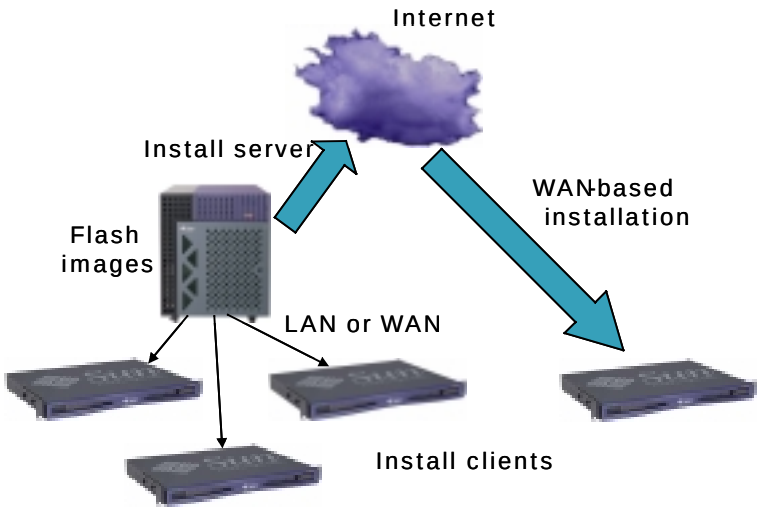
In the past, administrators had to use physical media, such as CDs or DVDs, to provision systems. They also had to be physically present for installations. For example, if a new system was needed in a Web farm, the administrator went to the site of the Web farm with the appropriate media to install the system manually. With the increasing demands for services, this mode quickly became impractical, impacting both agility and profitability. Solaris JumpStart™ software improves the situation by replacing physical media with media housed on local servers. However, this requires additional servers at remote sites, is not entirely suitable for wide area network (WAN) installations, and lacks the means to seamlessly upgrade systems. Figure 1 illustrates this method of inefficient provisioning.

Figure 1: Old Method of System Provisioning



With Solaris Flash, Secure WAN Boot, and Solaris Live Upgrade, administrators can move towards optimizing systems provisioning and change management models by automating the practice of building, testing, deploying, and maintaining systems over a LAN or WAN. Figure 2 depicts the new, automated method of system provisioning made possible by using these products.

Figure 2: New, Automated Method of System Provisioning



The efficiency and performance of deploying and maintaining systems by replicating existing systems with Solaris Flash and Secure WAN Boot, and upgrading them with Solaris Live Upgrade, all from a central administration site, have the following benefits:

- *Decreased downtime/increased availability*: Solaris Live Upgrade allows upgrades to system software and patches without affecting the running system.
- *Faster, consistent, controlled installs*: Installing systems with a Solaris Flash archive is faster than other methods, and because the archive is a “snapshot” of a master system, it provides consistency and control.

- *Increased security*: The new Secure WAN Boot tool provides increased security for WAN-based installations. Solaris Flash increases individual server security by enabling exact clones of securely configured systems.
- *Increased manageability*: By automating build-test-deploy-maintain models.
- *Lower TCO*: By decreasing downtime and increasing efficiency.
- *Scalability*: Solaris Flash and Secure WAN Boot allow environments to scale rapidly and consistently by cloning systems in local and remote sites.
- *Support for lights-out environments*: Through increased automation, efficiency, and consistency, these tools enable installation and upgrade methods that require little to no human intervention.

This white paper provides an overview of Sun's installation tools and when they should be used, explains how Solaris Flash, Secure WAN Boot, and Solaris Live Upgrade work, and gives examples of how to use them.

Chapter 2

An Overview of the Tools

Sun provides several overlapping tools in the Solaris™ Operating Environment (OE) to help administrators install and maintain systems. Although this paper focuses on provisioning and change management tools, Solaris™ Web Start software and Solaris JumpStart software are described below to help in determining which tool to use for specific situations.

- *Solaris Web Start software: For single system installations.*
  This software provides an easy way for novice administrators to deploy Solaris platform-based and other application software safely, easily, and economically. Based on Java™ technology, the latest tools provide ease of use in installing and setting up application software on the Solaris OE.
- *Solaris JumpStart software: Sun's enterprise-class, automated, hands-off installation tool.*
  A major benefit of Solaris Solaris JumpStart software technology is the ability to automate system installations so they can occur without human intervention. This is particularly important in large environments where new systems are always arriving and the ratio of systems to administrators is large, such as in a lights-out data center. Using DHCP, administrators can perform installations over a WAN, however, Solaris Solaris JumpStart software does not provide security for this method. Solaris Solaris JumpStart software is best employed in environments where there are no human operators and all operations are automated. With the new Secure WAN Boot technology, Solaris Solaris JumpStart technology can be extended securely to WAN environments.
- *Secure WAN Boot: For secure installs over a WAN or the Internet.*
  Sun's new Secure WAN Boot technology provides a method to securely boot and install systems over the Internet. Included with the Solaris 9 OE, this technology helps IT departments

manage a lights-out environment by enabling administrators to remotely install multiple, duplicate systems, such as Web servers or application servers, over geographically dispersed areas with little or no human intervention. With Secure WAN Boot, Sun solves most of the security issues that arise when using Solaris Solaris JumpStart software or other methods to install systems over WANs.

- *Solaris Live Upgrade: For software upgrade, maintenance, and patch management.* Solaris Live Upgrade significantly reduces the downtime associated with an operating system upgrade or maintenance. It enables the Solaris OE to continue running while an administrator is upgrading to the latest release, applying patches, or performing routine maintenance.
- *Solaris Flash: For faster, multiple installations.* Solaris Flash provides a method to create snapshots of entire systems, including applications and the system configuration. Solaris Flash archives can be used to replicate reference server configurations onto multiple clones to decrease installation times, and the disk space needed for Solaris JumpStart software images.

Solaris Flash, Solaris Live Upgrade, and Secure WAN Boot technologies are new tools specifically designed to simplify software provisioning and change management for distributed and replicated server environments, and are discussed in more detail in the following sections.

Solaris Flash

Solaris Flash is an inherent part of Sun's build-test-deploy-maintain model for systems provisioning. It provides a method to create a snapshot image, or Solaris Flash archive, of an entire system, including the Solaris OE, applications, and system configuration. Using a Solaris Flash archive, administrators can replicate reference server configurations, such as Web servers, onto multiple clone or client systems. Flash archives can be used to provide these functions:

- *For faster, flexible, efficient installations*: Solaris Flash archives can be used by Solaris Web Start, Solaris JumpStart, Solaris Live Upgrade, and Secure WAN Boot software to quickly install local and remote systems.
- *For system backups*: A Solaris Flash archive of a system can be created and copied to CD or DVD, so administrators can restore the system to its original configuration. However, the system needs to be rebooted from a Solaris OE CD or the network before the archive can be installed.
- *For system provisioning*: Solaris Flash archives enable rapid, consistent deployment of multiple systems.
- *To reduce TCO*: Solaris Flash archives can be compressed, reducing the disk space and number of servers needed for storing Solaris JumpStart software images.

Creating and Testing Reference Configurations

A base configuration, containing the Solaris OE and current patches for the type of server to be installed, must be created and thoroughly tested on a system with a similar kernel architecture. (It is possible to create the base configuration on a platform with a different kernel architecture, however, it must be modified at the end of the installation with Solaris JumpStart software scripts. (See the various Sun BluePrints™ papers by John S. Howard.)

To help increase the security of individual systems, administrators can remove unnecessary software on systems that provide specific functions. For example, a standard configuration for Web servers can be created that uses a stripped-down, secure version of the Solaris OE. Since every Web server will then use the exact same configuration and are essentially clones of the original, the chance of a security breach due to a configuration error can be significantly reduced.

After the base configuration is installed, the administrator determines which hardware will be resident on the target system and manually installs the corresponding drivers and any necessary patches.

For a modular approach, application profiles can be created and added to the base configuration to create specific service images. For example: Application server, database server, Web server, and cache server. Figure 3 illustrates how base configurations and applications profiles can be combined to create service images, and the resulting Solaris Flash Archives.

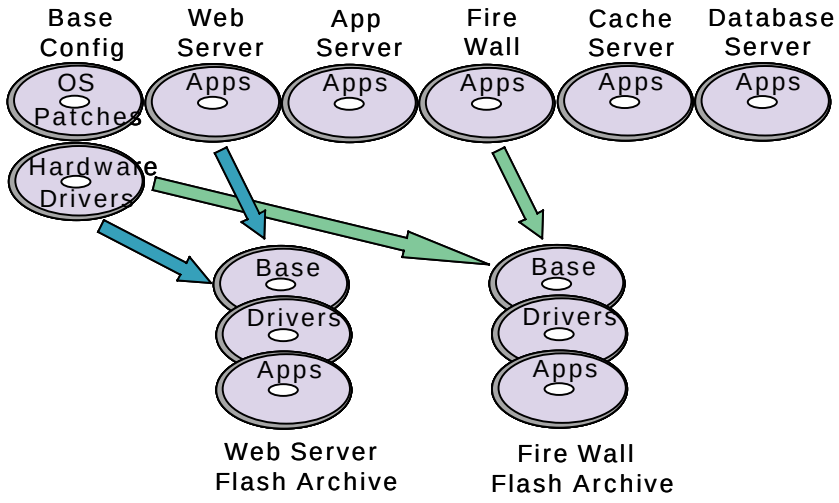


Figure 3: Base Configurations, Application Profiles, and Solaris Flash Archives

Creating a Solaris Flash Archive

After a service configuration has been created and tested, a Solaris Flash archive can be created from it. When a Solaris Flash archive is installed on a system, all of the files in the archive are copied to that system, giving the newly installed system exactly the same installation configuration as the original system. Installing a new system with Solaris Flash archives is much faster than installing with a Solaris JumpStart software image, because the files are simply copied to the target system rather than installed individually through pkgadd, which must update the package database after each package is installed. In this way, using Solaris Flash archives can reduce a four- to five-hour task to as little as 20 minutes.

Once the archives have been created they may be copied to an NFS server, HTTP server, local files or tape, CD, or DVD. The archives are then available for installation by Solaris Web Start, Solaris JumpStart, Solaris Live Upgrade, and Secure WAN Boot software. Table 1 illustrates the various archive locations and the installation methods for accessing them.

TABLE 1 Solaris Flash Archive Install Methods and Archive Locations

Install Method/ Archive Location	Solaris Web Start	Solaris JumpStart	Solaris Live Upgrade	Secure WAN Boot
NFS	X	X	X	
HTTP	X	X	X	
HTTPS	X	X		X
FTP	X	X		
Local Media	X	X	X	
Local Tape	X	X		

Solaris Live Upgrade

Performing upgrades and routine patch maintenance to the Solaris OE and other applications, can significantly impact the availability of systems and services. Systems running mission-critical operations, such as those in data centers, can rarely afford the downtime needed to execute these tasks.

Solaris Live Upgrade provides a method of upgrading and patching systems that substantially reduces the usual service outage associated with these functions. It enables the Solaris OE (versions 2.6, 7, 8, and 9) to continue to run uninterrupted while the administrator upgrades to the latest release of the operating environment, applies patches or performs routine maintenance on the inactive or duplicate boot environment. The original system configuration remains fully functional and unaffected by the upgrade or the installation of a Solaris Flash archive. When satisfied with the process, the administrator simply reboots the system to run the latest or updated OE. If the newly activated boot environment should fail for any reason, the administrator can fall back to the original by simply rebooting the system.

Solaris Live Upgrade delivers a framework to create, manage, manipulate, and activate multiple boot environments because it:

- Supports splitting, merging, or sharing file systems between boot environments.
- Allows migration of file systems from one device to another. This enables administrators to migrate a software environment to other file system types, sizes, and layouts without affecting the configuration of the original environment. For example, it often happens that a system will outgrow its root partition. When this happens, administrators apply a quick fix by symbolically linking files to other partitions. Solaris Live Upgrade can be employed to migrate the files to a larger partition without affecting the operation of the system.
- Eliminates service outages associated with normal test and evaluation processes. If the new boot environment fails, the administrator can fall back to the original, providing a mechanism to analyze the cause of the failure.
- Offers patch management, so that patches can be installed and tested on the inactive boot environment and rolled to the active environment when the administrator is satisfied that they are stable.

- Provides backup for Solaris Flash archives, which can be created and installed on an alternate boot environment to be used for system backup.
- Speeds system provisioning by allowing a system to have more than one service environment installed on it. For example, a Web cache server can have a Web service installed on the alternate boot environment. If the workload requires more Web servers, the cache server can be rebooted, instantly changing it into a Web server.

Solaris Live Upgrade is volume manager-aware — that is, it is capable of functioning with boot disks managed by a logical volume manager. The source boot environment for the root file system can be a metadevice or volume, but the target boot environment cannot be a metadevice or volume. The inactive boot environment must be a regular slice.

After activating and booting a boot environment, the boot disk can be mirrored using VERITAS Volume Manager (VxVM) software or Solaris Volume Manager software.

VxVM software requires additional reboots during the boot disk encapsulation process and Solaris Volume Manager software requires additional reboots during the root mirroring process. Using Solaris Live Upgrade with VxVM software or Solaris Volume Manager software does not increase downtime or reboots for either of these processes.

There are some limitations when using Solaris Live Upgrade with VxVM software, including difficulty falling back to the original boot environment and dependencies on the order and method in which VxVM software packages are removed during upgrades. These limitations are expected to be addressed in Solaris Live Upgrade 2.1. Additionally, future versions of the Solaris 9 OE are expected to include enhancements that will make this process easier.

Creating a Boot Environment

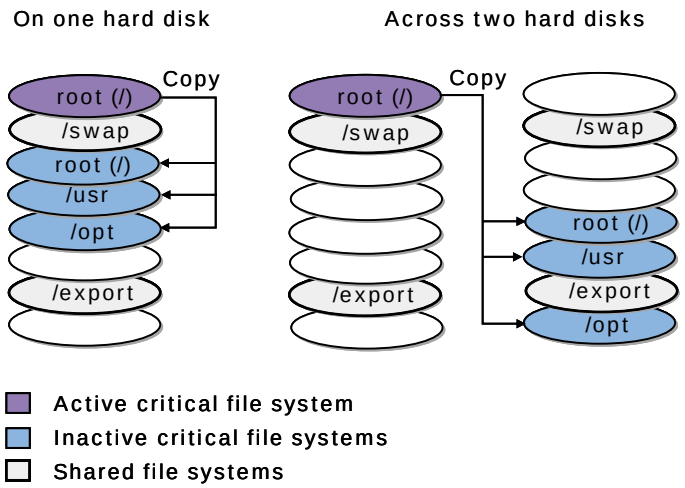
A boot environment is a group of file systems and their associated mount points. Boot environments can be created on the same or separate disks. The active boot environment is the one that is currently booted and used by the system. All others are considered to be inactive or alternate boot environments.

When creating a boot environment, Solaris Live Upgrade distinguishes between two file system types: critical file systems and shared file systems. Critical file systems are required by the Solaris OE and are separate mount points in the `vfstab` of the active and inactive boot environments. Examples of critical file systems are `root(/), /usr, /var, and /opt`. These file systems are always copied from the source to the inactive boot environment.

Shared file systems are the user-defined file systems such as `/export` that contain the same mount points in `vfstab` in both the active and inactive boot environments. Updating shared files in the active environment also updates them in the inactive environment. These files are shared by default, but can be copied to the inactive boot environment if specified (for example, for system backups).

Creating an inactive boot environment entails copying critical file systems to another slice. Identifying an unused slice and reconfiguring the file systems are the first steps. File systems can be reconfigured by splitting and merging them to suit the needs of the administrator by editing the `vfstab` file. After the file systems are configured on the inactive boot environment, automatic copy of critical file systems can begin. In Figure 4, the root file system is split and copied to the inactive boot environment, creating a boot environment on one hard disk and across two hard disks.

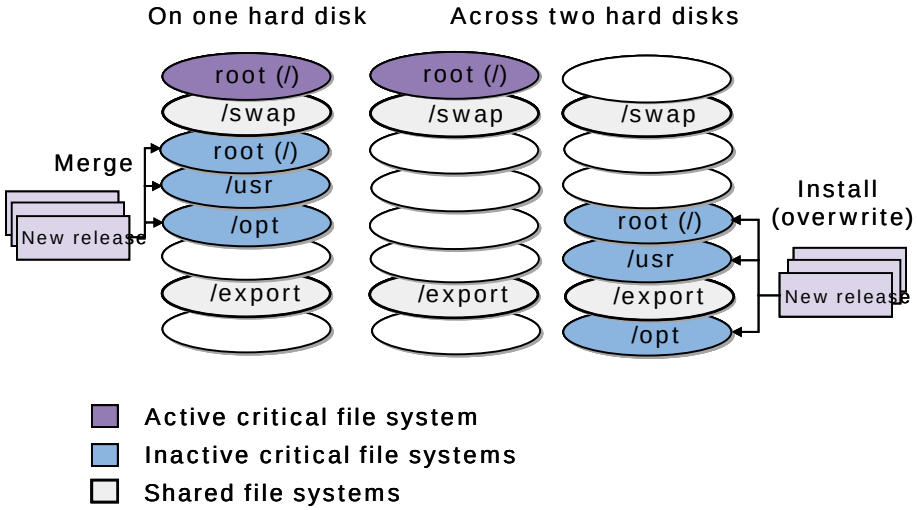
Figure 4: Creating a Boot Environment



Upgrading a Boot Environment

The newly created boot environment remains unchanged until the administrator is ready to modify it by applying patches, upgrading the OS or applications, or installing a Solaris Flash archive as shown in Figure 5. Using a Solaris Flash archive to install a new version of the system is an excellent way to help ensure consistency across many servers. However, similar to an initial install, it overwrites all of the files in the boot environment. Modifying the inactive boot environment does not have any affect on the active boot environment, allowing the administrator to perform these normally rushed tasks in a less time-constrained and controlled manner during regular working hours. Eliminating the need for overtime and weekend shifts can also have the benefit of reducing errors associated with upgrading systems in a short time period.

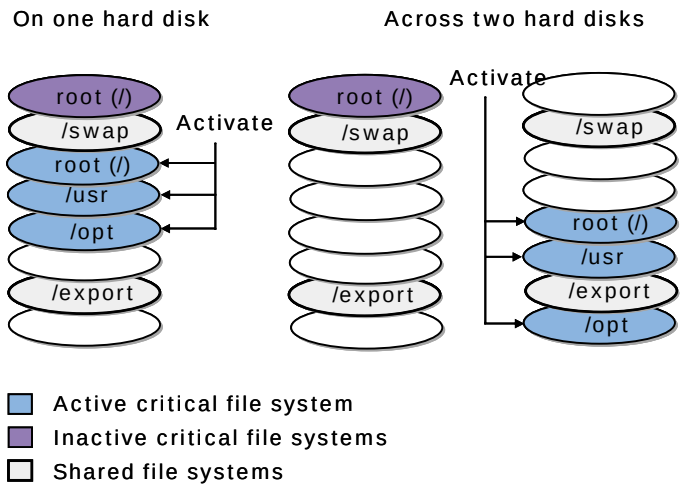
Figure 5: Upgrading or Installing a Solaris Flash Archive on an Inactive Boot Environment



Activating an Inactive Boot Environment

Switching to the inactive boot environment is accomplished by activating it and rebooting the system. Activating the inactive boot environment makes it bootable and synchronizes some files (such as the passwd file) between the active and inactive boot environments. When the system is rebooted, the configuration that was installed on the inactive boot environment becomes the active system, and the original becomes inactive, as illustrated in Figure 6.

Figure 6: Activating a Boot Environment



The fall back feature of Solaris Live Upgrade eliminates the time-consuming procedure of backing up and restoring the original configuration in case the new configuration fails. The ability to immediately boot back to the original system greatly decreases the risk of upgrading and gives the administrator an opportunity to fully analyze the failure.

Secure WAN Boot

New in the Solaris 9 OE, Secure WAN Boot technology provides a method to securely boot and install new systems over the Internet.

Secure WAN Boot provides security over the Internet and insecure WANs with the following measures:

- Peer Authentication — Verifies the identity of the client and server by exchanging digital certificates.
- Data Confidentiality — Encrypts information for transmission to prevent a third party from reading it.
- Data Integrity — Uses digital signatures to verify that a third party has not modified the information received.

Using Secure WAN Boot for Internet-based installs can help lower a company's total cost of ownership (TCO) by:

- Enabling secure system deployments, both locally and remotely.
- Reducing necessary infrastructure (Solaris JumpStart servers, disk space) by using compressed Solaris Flash archives.
- Reducing network costs by decreasing transmit time and using public networks.

- Increasing efficiency by centralizing administration. Difficult administration tasks (setting up install, boot, and DHCP servers) can be centralized, allowing junior administrators to install remote systems per company standards in a consistent, secure manner).
- Increasing scalability by enabling remote installations of additional systems in Web and application farms, as well as other environments.
- Automating upgrades in situations where initial installations are acceptable. (Secure WAN Boot uses Solaris Flash archives, which overwrite existing configurations.)

Deploying Secure WAN Boot is performed in two steps:

1. Setting up the install server, boot server, and DHCP servers
2. Installing the remote client

Setting up the servers involves installing and testing master configurations, creating Solaris Flash archives of the masters and storing them on the install server, installing miniroot boot images on the boot server, and configuring the DHCP server with security and location information.

The remote client installation procedure takes place in three steps.

1. The remote client boots and uses unicast DHCP to talk to the DHCP to retrieve information it needs to continue, such as the location of the boot and install servers. The client then downloads the `wanboot` binary from the boot server.
2. The client executes the `wanboot` binary, which downloads an encrypted security payload. Next, it uses the security payload to set up an SSL connection with the DHCP server, which it uses to download a Solaris miniroot from the boot server. Finally, the client executes the miniroot, downloads the install image from the install server, and installs the image.

For more information on Secure WAN Boot, see *Secure WAN Boot — Towards a Lights-out Environment*. Secure WAN Boot is expected to be available in the Solaris 9 OE update 2.

Chapter 3

Using Solaris Flash and Secure WAN Boot

Deploying New Systems to the Field

Two very distinct system administration problems encountered when supporting field offices can be solved using Solaris Flash: deploying new systems, and maintaining them.

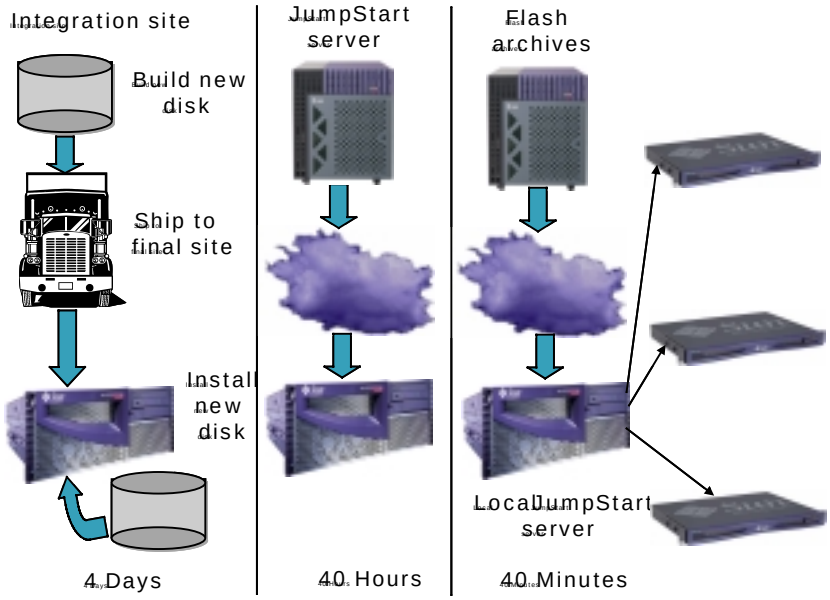
For example, ACME is a large company with offices distributed throughout the country. It needs to upgrade 300 servers with 40 to 50 applications running on several versions of the Solaris OE, while finding a way to deploy new systems more cost-effectively. A constraining factor to upgrading is that the upgrades must be performed during the eight-hour window of the third shift on weekdays. To reduce overtime expenses, no weekend work is allowed.

In the old upgrade model, upgrading the OS, patches, or applications involves building new boot drives at the integration site and mailing them to the remote offices for installation. This method is extremely inefficient, expensive, and error-prone. In an attempt to automate the process, initial tests show that it takes 40 hours to install the Solaris OE and distribute the applications over a WAN using Solaris Solaris JumpStart software.

ACME can develop a new upgrade model by configuring a master system that includes the Solaris OE, patches, plus all 50 of the software packages, then creating a Solaris Flash archive of it the master system. Using Secure WAN Boot to enable secure transmission over the Internet, the administrators can install the Solaris Flash archive on one server in each remote office. After the newly installed server is verified to be intact, it is used as a Solaris JumpStart/Flash server for installing the remaining systems in the office. With this new Solaris Flash model, depicted along

with the old models in Figure 7, ACME will be able to reduce the installation from 40 hours to 40 minutes, significantly lowering the time and expense of upgrading systems.

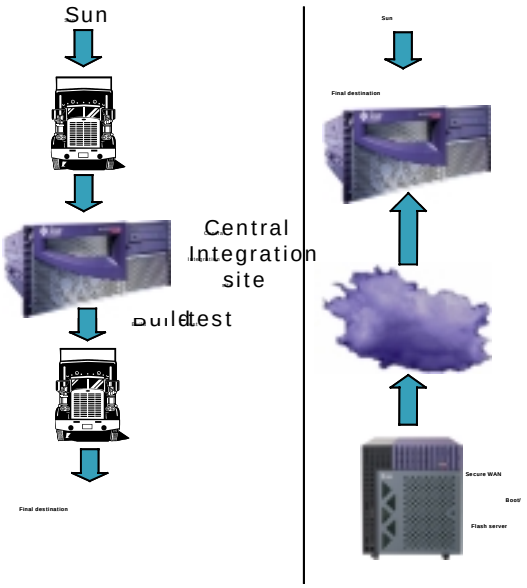
Figure 7: Old and New Upgrade Models



ACME can also leverage the upgrade model to deploy new systems in the field. In the old system deployment model, ACME ships the new systems to a central integration site where they are loaded with the proper software and then shipped to their final destination. This method is time consuming and expensive in terms of staff and double freight charges.

In the new model, new systems are shipped to the remote offices and installed using Secure WAN Boot and Solaris Flash archives, greatly reducing staff and shipping costs. Figure 8 shows the new and old models for system deployment.

Figure 8: Old and New Deployment Models



Rapidly Replicating/Cloning Systems

Large Internet service providers (ISPs) frequently need to add multiple new systems in a LAN to satisfy the increasing demands of their customer bases. In this example, an ISP needs to install an additional 100 new Web servers to its server farm. In the past, the servers might have been individually installed in a manner similar to building custom cars. Or they may have been installed using a production-line, but still time-intensive, method such as Solaris JumpStart software.

However, by using Solaris Flash software, the ISP can implement systems provisioning and change management as a more efficient build-test-deploy-maintain model. This enables the ISP to apply a cookie-cutter approach to deploying systems, creating standard platforms and rapidly replicating them onto multiple, clone servers in a fraction of the time it takes to install systems with conventional methods, as shown in Figure 9.

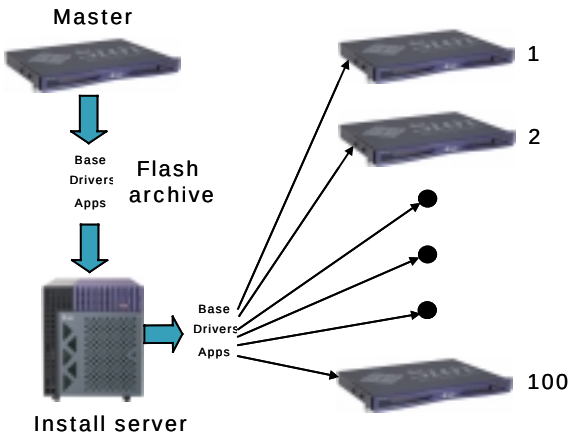


Figure 9: Replicating a Standard Platform to Multiple Clone Servers in a LAN

System Backup for Disaster Recovery

Several federal regulatory agencies require banks and financial institutions to maintain disaster recovery protocols. Backing up systems to multiple tapes or other media in order to transport them to the disaster recovery site is a time-consuming and error-prone operation. Additional problems often occur while reinstalling the systems at the recovery site.

Using Solaris Flash, administrators can create a compressed stack of an entire system and save it to a variety of locations including media such as DVDs and CDs, as well as a wide range of servers including NFS, FTP, IFTP/BOOTP, HTTP, or HTTPS. The archives can then be securely installed over a WAN using Secure WAN Boot (with the appropriate servers), or any of the other installation methods offered by Sun. Because the images are compressed, they consume much less space than traditional back-up methods, helping to reduce the cost of providing a disaster recovery protocol. In addition, installation times can be drastically reduced, in some cases up to 80 percent, enabling fast recovery of lost services.

Providing Revision Control

Using Solaris Flash, administrators can implement a high level of revision control for applications deployment. For example, revision 1.0 of a Web server — having a bill of materials that includes the OS, patches, agents, Web server, and applications — can be tested and deployed to n servers. As new patches and revisions of software arise, the administrator can test modifications to the Web server stack and label it revision 1.01, deploying the update to n servers as the maintenance schedule permits. If a problem is discovered in production with v1.01, the administrator can roll back to v1.0. Treating the complete application stack as a single, manageable object is a key step in providing a build-test-deploy-maintain model.

Field Replaceable Unit (FRU) Servers

Replacing the failed system is often much faster and more efficient than trying to troubleshoot it. Solaris Flash allows administrators to take an FRU approach to a complete server. Storing compressed Solaris Flash archives of servers and keeping spare systems helps the administrator install and configure a replacement server in a relatively short period of time.

Chapter 4

Using Solaris Live Upgrade

Increasing availability and reducing administration downtime and risk are the main benefits of using Solaris Live Upgrade. By performing behind-the-scenes upgrades and patch management, Solaris Live Upgrade allows administrators to maintain systems with a fraction of the downtime previously required. And the ability to quickly revert failing systems to their prior configuration significantly decreases the risk of unplanned downtime.

Single Server Environments

Solaris Live Upgrade fits into the build-test-deploy-maintain model by housing test, production, and backup systems on a single server, and allowing nondisruptive (except for boot times) upgrades. For example, the production environment can be on the active boot environment while the test system is on an alternate boot environment. The two can be flip-flopped after each successful software upgrade. Backing up the active environment to a third, inactive boot environment on a daily basis gives the administrator the ability to do things such as configuring alternate SCSI paths to disk arrays, or backing up to other media without affecting the active environment.

Upgrading the Solaris Operating Environment

The time and risk involved with upgrading the Solaris OE can be greatly reduced by using Solaris Live Upgrade and Solaris Flash. For example, a large online catalog company needs to upgrade its Web servers.

To avoid impacting capacity, upgrading any large Web farm must be done in segments. Typically, upgrades are performed on ten percent of the total servers in the farm at a time. In the past, installing, rebooting, testing, and bringing ten percent of the servers back online could take six hours. Cycling through the remaining nine segments of the pool would yield a total linear time of 60 hours, with an average of ten-percent reduction in the capacity of the pool. If this reduction in capacity was not acceptable for peak traffic hours, the total upgrade could be split into overnight operations of eight-hour windows, requiring nine to ten days to complete.

Using Solaris Live Upgrade and Solaris Flash, the complete pool can be upgraded without taking a single system offline. If bandwidth allows, the previously four-hour upgrade can be accomplished in 15 minutes. Booting and test cycling the systems is still performed in segments to keep offline capacity at a maximum of 10-20 percent. Assuming the boot/test cycle takes approximately one hour[1], and using larger segments, the complete Web farm upgrade can be completed in one overnight window, while maintaining 80-90 percent capacity.

If the upgrade should fail for any reason, the affected servers can fall back to the original configuration with a single reboot, allowing the administrators to analyze the failure. This method limits operations liability and the risk of planned downtime encroaching into unplanned downtime due to upgrade failures.

Provisioning/Resource Management

Solaris Live Upgrade can be employed to instantly provision systems in a resource management-like manner, giving administrators the ability to immediately respond to changes in workload. For example, a server can be installed to provide a particular service, such as caching, while an alternate service, such as Web hosting, is installed on an inactive boot environment. When the load dictates, the server can be rebooted to function as a Web server, as shown in Figure 8.

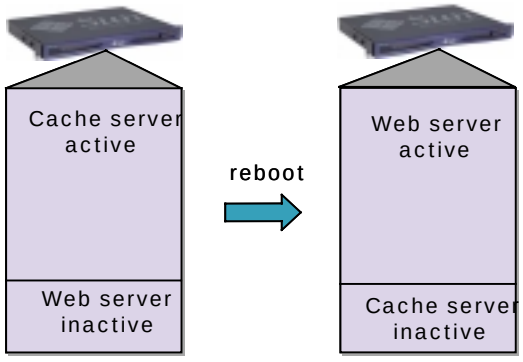


Figure 10: Instant Systems Provisioning via an Alternate Boot Environment

1.Time calculations are for example only, and are not indicative of actual performance. Installation and boot times are highly dependent on individual configurations.

Chapter 5

Conclusion

Today, more than ever, the ability to manage systems in a predicable manner while quickly reacting to change is a critical factor in business success. Reducing TCO while increasing productivity and efficiency are other challenges facing IT managers and administrators.

As a global manufacturer of advanced computer systems hardware and software, Sun is well aware of these needs, and believes that providing tools for automating a build-test-deploy-maintain model for system provisioning and change management will enable companies to meet their needs.

Solaris Flash

- Provides a complete build-test-deploy-maintain model for fast, consistent, efficient systems provisioning of multiple servers.

Secure WAN Boot

- Provides the ability to securely boot and deploy WAN and Internet-based installations for remote environments.

Solaris Live Upgrade

- Allows behind-the-scenes software upgrades and patch maintenance, decreasing downtime and risk involved with change management. Additionally, permits instant systems provisioning and alternate backup options. Provides a complete build-test-deploy-maintain model within a single system.

Organizations implementing system provisioning and change management with a build-test-deploy-maintain model utilizing these tools can feel confident that they will be able to meet and productivity goals in a consistent, efficient, and predictable manner.

Chapter 6

References

Sun Microsystems posts complete information on Sun's hardware and software products and service offerings in the form of data sheets, specifications, and white papers on its Internet Web page at *http://www.sun.com/*.

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