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## Introducing Oracle Solaris 11 Express – What's New for System Administrators

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## Introduction

The Oracle Solaris 10 operating system is widely deployed to support today's strategic enterprise applications. Well-known for the innovative technologies that it integrates, Oracle Solaris 10 features the ZFS file system for superior data integrity, Trusted Extensions for advanced security, and performance that scales due to efficient thread scheduling on multi-core processors. Oracle Solaris 10 offers built-in virtualization with minimal overhead through Zones (Oracle Solaris Containers) that isolate applications and optimize system resource allocations, making consolidation an effective method of reducing costs. Innovations like DTrace, Predictive Self-Healing, and the Service Management Facility (SMF) make Oracle Solaris 10 the operating system (OS) of choice for applications that demand business-critical performance and availability.

While Oracle Solaris 10 sets the standard for mission-critical enterprise operating systems, Oracle Solaris 11 raises the bar. In this next-generation release, Oracle continues the pattern of innovation, building on the many groundbreaking technologies introduced in Oracle Solaris 10. At the same time, Oracle preserves the long-standing guarantee of binary compatibility – applications that run on previous Oracle Solaris releases can still run unchanged on Oracle Solaris 11 within the same processor architecture: x86 or SPARC.

To allow customers to transition smoothly to Oracle Solaris 11, Oracle is releasing Oracle Solaris 11 Express. Oracle Solaris 11 Express is a production-quality, fully supported release that allows system administrators to deploy the OS with confidence while learning about its new features and administrative tools. With over 2,700 projects, 400 inventions, and support for over 11,000 applications, Oracle Solaris 11 Express has been tested and optimized to form an integral part of the comprehensive Oracle applications-to-disk stack.

As with Oracle Solaris 10, the Oracle Solaris 11 Express release maintains an intense focus on performance and scalability, efficiency, security, and availability (see Figure 1). At the same time, it includes state-of-the-art technologies that enhance ease of use and manageability, streamlining administrative duties, simplifying consolidation efforts, and expediting application deployment. This paper introduces what's new in Oracle Solaris 11 Express and highlights how administrative tasks differ with this release. In addition, it presents migration strategies to consider when first downloading and deploying this new release.



Figure 1. Oracle Solaris 11 Express builds on the four pillars underpinning Oracle Solaris 10: scalability, efficiency, security, and availability.

## What's New in Oracle Solaris 11 Express

A key design goal of Oracle Solaris 11 Express is to improve ease-of-use and manageability so that administrators can maintain systems and application stacks effectively and with less cost. This release adds new functionality and streamlines common software and systems management tasks, with specific enhancements in the following areas:

- **Scalability:** Oracle Solaris 11 Express scales to thousands of threads, terabytes of memory, and hundreds of Gbps of network bandwidth. As Oracle develops new server products, this OS will support evolving, state-of-the-art hardware platforms as well as current x86 and SPARC platforms.
- **Efficiency:** To support consolidation initiatives effectively, Oracle Solaris 11 Express is a fully virtualized operating system with technologies that span network, storage, and server virtualization. A gradual migration path to Oracle Solaris 11 Express exists by running applications within Oracle Solaris 10 Branded Containers, which can simplify a transition to Oracle Solaris 11.
- **Security:** Providing a fully “secure-by-default” environment, Oracle Solaris 11 Express advances data and system security with on-disk ZFS encryption, delegated zone administration, and support for certification of the operating system at boot time.

- **Availability:** A significant benefit in implementing this release is that Oracle Solaris 11 Express eliminates the current software maintenance model of applying patches. New utilities and a comprehensive software packaging model provide a more effective approach to software lifecycle maintenance, which helps to reduce both planned and unplanned downtime. Included are tools to clone and roll back to a previous snapshot of a boot environment, enabling safe upgrade capabilities similar to those provided by Oracle Solaris 10 Live Upgrade. In addition, Oracle Solaris 11 implements root on a ZFS file system to enhance data integrity.

By releasing Oracle Solaris 11 Express, Oracle paves the way to transition to Oracle Solaris 11. By deploying Oracle Solaris 11 Express today, customers and ISVs can access the latest innovations, and administrators can learn how to manage systems using new tools and ease-of-use features. Oracle Solaris 11 Express is the result of years of open source development and engineering contributions, and is fully supported as a production release under the Oracle Premier Support for Operating Systems service offering (see <http://www.oracle.com/solaris>).

Table 1 summarizes the primary changes that impact administration when moving to Oracle Solaris 11 Express. The remainder of this guide discusses these changes and points out documentation and man pages where administrators can learn more about what's new.

**TABLE 1. OVERVIEW OF WHAT'S NEW IN ORACLE SOLARIS 11**

TASK	TECHNOLOGY IN ORACLE SOLARIS 10	TECHNOLOGY IN ORACLE SOLARIS 11
Planning a migration to the next major release	Oracle Solaris 8 and Solaris 9 Branded Containers running on Oracle Solaris 10	Oracle Solaris 10 Branded Containers running on Oracle Solaris 11
Installing systems	<ul style="list-style-type: none"> <li>• Interactive: Install DVD</li> <li>• Automated: Oracle Solaris JumpStart</li> </ul>	<ul style="list-style-type: none"> <li>• Interactive: Install CD &amp; package repositories</li> <li>• Automated: Automated Installer &amp; package repositories</li> </ul>
Packaging model	SVR4 packaging	Image Packaging System (IPS); support for SVR4 packaging commands for application installs
Maintaining system software	SVR4 Patching	Updates via package repositories, Package Manager, Update Manager, <code>pkg image-update</code>
Safe OS upgrade	Live Upgrade	ZFS cloned Boot Environments, which are managed with <code>beadm</code>
Building a customized distribution image	Blueprints for custom DVDs	Distribution Constructor to create ISO and virtual machine images

## Planning a Migration to Oracle Solaris 11 Express

Oracle continues the Solaris commitment to binary compatibility across hardware architectures that began in 1997 – a promise that simplifies migrations between major Oracle Solaris releases and allows applications to take advantage of performance gains from Oracle's newest SPARC and x86 hardware systems. In addition to binary compatibility within a specific architecture, Oracle guarantees source

code compatibility across different machine architectures, allowing software providers to simply recompile applications across hardware architectures.

Administrators can prepare for a migration by having a sound understanding of key features in Oracle Solaris 10, including Oracle Solaris Zones, ZFS (especially to support root file systems), and Live Upgrade. As the remainder of this paper discusses, Oracle Solaris 11 Express builds upon these features, so having a solid working knowledge of them can help to prepare for a transition.

Oracle offers several migration paths for transitioning applications to Oracle Solaris 11. Applications can run either directly on Oracle Solaris 11 Express in global or non-global zones (see Figure 2). The release also supports Oracle Solaris 10 Branded Containers (center, Figure 2) hosted within an Oracle Solaris 11 Express global zone. Just as Oracle Solaris 8 and 9 Branded Containers helped to transition applications to Oracle Solaris 10, Oracle Solaris 10 Branded Containers in Oracle Solaris 11 Express can enable a more gradual, stepped approach to an OS migration.

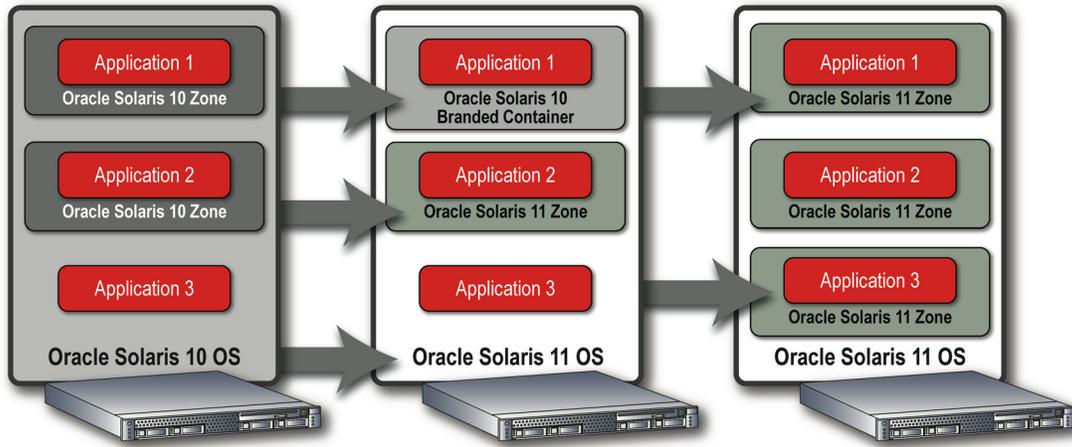


Figure 2. Oracle Solaris 10 Branded Containers provide an option when transitioning to Oracle Solaris 11 Express.

For more information about Oracle Solaris 10 Branded Containers, see [System Administration Guide: Oracle Solaris Zones, Oracle Solaris 10 Containers, and Resource Management](#).

## Installing Systems

Oracle Solaris 11 Express offers a number of installation options:

- Interactive installation using a text-based user interface (since most servers use a text-based console for installation).
- Interactive installation for x86 desktop systems using the Oracle Solaris 11 Express LiveCD for x86.
- An improved “hands-off” automated installation process that goes beyond Oracle Solaris JumpStart functionality in Oracle Solaris 10 and earlier releases. (See Automating Installations of Multiple Systems in the Enterprise, page 11, for more detail.)

Oracle Solaris 11 Express streamlines interactive installations, basing them on the guiding principle of installing a fixed software payload. Interactive installations make assumptions about basic system configurations, reducing the need for input and shortening the installation process.

After an initial installation completes, the installed software collection can be easily minimized or extended using the Package Manager software update tool (see *Maintaining System and Application Software*, page 7). To simplify system configuration after the installation, Oracle Solaris 11 Express contains enhanced SMF profiles that perform necessary configuration tasks when SMF services are first initialized after installation and reboot.

There are two important changes from the Oracle Solaris 10 installation process:

- Oracle Solaris 11 Express must be installed on a ZFS root file system. ZFS offers significant benefits to administrators in terms of data integrity, management flexibility, ease of use, and the ability to snapshot and clone file systems, which simplifies maintenance and enables safe upgrades.
- During installations of Oracle Solaris 11 Express, the install process configures an initial user account – this is because, by default, root is a role rather than a user. This change enhances security since the operating system logs an audit event whenever a user assumes the root administrative role or executes a command with root privilege.

### Text-Based Interactive Install

The console text-based installer supports interactive installations of x86 and SPARC servers (see Figure 3). This installer steps through a process similar to that of the graphical LiveCD, but installs a basic selection of software suited for server deployments (i.e., it does not install desktop components such as a graphical desktop environment, or audio and wireless networking drivers).

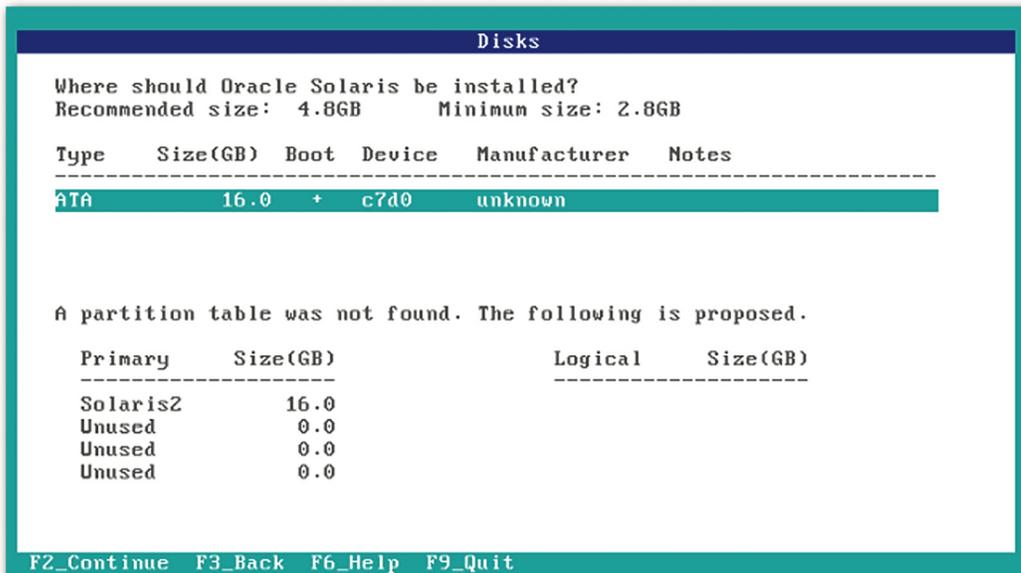


Figure 3. Text-based installer.

## Graphical LiveCD

The Oracle Solaris 11 Express LiveCD for x86 allows users to run an in-memory boot environment that gives users the opportunity to evaluate the OS or proceed directly to installation. The GUI-based interactive installation (see Figure 4) steps through the process of identifying the target system disk(s), date and timezone settings, language selection, and the task of defining an initial user account. The LiveCD then installs a software payload that includes a full desktop operating environment.

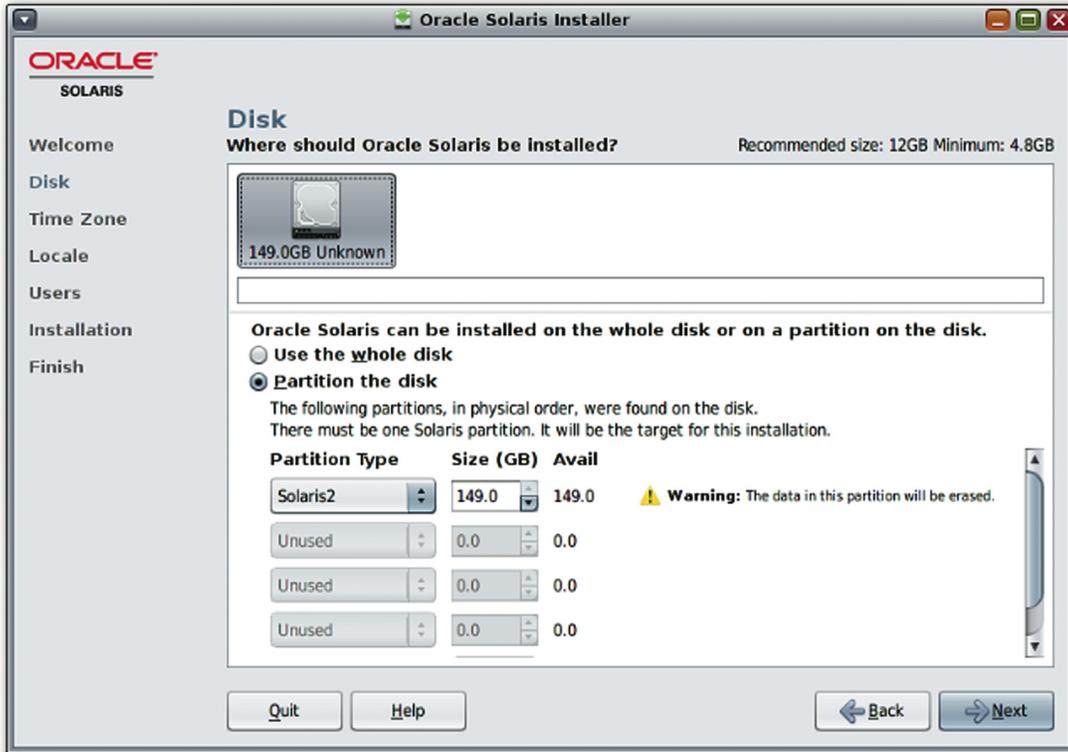


Figure 4. Oracle Solaris 11 Express GUI-based installation (disk setup).

For sight-impaired users, Oracle Solaris 11 Express improves accessibility for x86 desktop installations. From the x86 bootloader, a user can start the LiveCD environment with a screen reader (using the eSpeak speech synthesis engine) or select a screen magnifier.

For more information about installations, see [Getting Started With Oracle Solaris 11 Express](#).

## Maintaining System and Application Software

Based on extensive customer feedback about patch and upgrade processes for Oracle Solaris 10, Oracle engineers completely redesigned the software packaging system in Oracle Solaris 11 Express. Oracle Solaris 11 Express presents a significant change for system administrators because of its new software packaging model – the Image Packaging System (IPS). IPS is a comprehensive delivery framework that spans the complete software lifecycle, addressing software installation, updates, system upgrades, and the removal of software packages. In contrast to the SVR4 packaging model used in earlier Oracle Solaris releases, IPS eliminates the need for patching. Relying on the use of software repositories, IPS dramatically changes how an administrator updates system and application software. A design goal behind the development of this new model (in addition to simplifying software lifecycle maintenance and improving reliability) is compatibility with zones and other installation contexts.

From the perspective of keeping system software up-to-date, the IPS framework greatly simplifies software maintenance. For Oracle Solaris 10 and earlier releases, patching is often a complex manual process requiring manual patch analysis to understand dependencies and to determine and apply appropriate patches. With the former patching process, administrators sometimes inadvertently introduced problems when appropriate patches were not applied or patch dependencies were not well understood. With Oracle Solaris 11, the IPS model reduces the risk of introducing incompatibilities or problems resulting from human error since all updated OS packages are fully integration-tested before download and installation.

### IPS Repositories

IPS relies on network-accessible or locally available software repositories as a delivery mechanism, which is similar to how other operating systems (notably Oracle Enterprise Linux) supply software updates. During a package install, IPS performs automatic dependency checking, adding additional packages, such as libraries, that might be required. Administrators can easily set up and manage local repositories to deploy both OS and application packages within network-restricted environments. Repositories are also easily mirrored, allowing an administrator to optimize for more efficient access.

Table 2 lists default network-accessible repositories for Oracle Solaris 11 Express.

**TABLE 2. ORACLE SOLARIS 11 EXPRESS REPOSITORIES**

REPOSITORY	DESCRIPTION
<a href="http://pkg.oracle.com/solaris/release">http://pkg.oracle.com/solaris/release</a>	Default repository for Oracle Solaris 11 Express. This repository contains updates for each new release of Oracle Solaris. Significant bug fixes, security updates and new software may be provided at any time for users to install at Oracle's discretion.
<a href="https://pkg.oracle.com/solaris/support">https://pkg.oracle.com/solaris/support</a>	Support repository providing the latest bug fixes and updates. Access is restricted to users with current Oracle Solaris support contracts.

## Package Management

IPS provides these interfaces to manage software packages:

- A command-line interface, the `pkg (1)` command and associated subcommands.
- A graphical user interface to search and manage installed packages called the Package Manager, which can be initiated on the command line by `packagemanager (1)`. A related GUI, called the Update Manager, initiated on the command line by `updatemanager (1)`, can be used to oversee full system updates.

Table 3 shows IPS command line equivalents for a few frequently used SVR4 packaging commands. While IPS packaging is the default packaging technique for Oracle Solaris 11 Express, SVR4 packaging tools such as `pkgadd (1M)` are still provided for compatibility to support installations of SVR4-packaged application software.

**TABLE 3. IPS AND SVR4 PACKAGING COMMANDS**

TASK	IPS COMMANDS	SVR4 PACKAGING COMMANDS
Install package	<code>pkg install</code>	<code>pkgadd -a</code>
Display package state and version information	<code>pkg list</code>	<code>pkginfo</code>
Verify package installation	<code>pkg verify</code>	<code>pkgchk -v</code>
Display package information such as license	<code>pkg info</code>	<code>pkginfo -l</code>
Display contents of a package	<code>pkg contents</code>	<code>pkgchk -l</code>
Search for a package	<code>pkg search</code>	<code>pkgchk -l -p</code>
Uninstall a package	<code>pkg uninstall</code>	<code>pkgrm</code>

Figure 5 and Figure 6 show the Package Manager and Update Manager interfaces, respectively. Update Manager reconciles all system software packages, bringing the base OS environment to a defined and integration-tested level (packages within zones are not impacted – see *Boot Environments and Zones*, page 11). Package Manager, on the other hand, allows an administrator to add, remove, or update individual packages between full system update operations. Both interfaces provide descriptive details about each package (including a date and time stamp to identify versions), making software management a more intuitive process. Package Manager also groups packages by category to simplify locating a specific package.

Both Package Manager and Update Manager can check package versions against packages in a specified repository and identify when updates for installed packages are available. The “Update All” function in Package Manager updates all installed packages, as does “Update All” in Update Manager. The command line equivalent for updating all packages is “`pkg image-update`”.

For more information on IPS, see the [Oracle Solaris 11 Express Image Packaging System Guide](#).

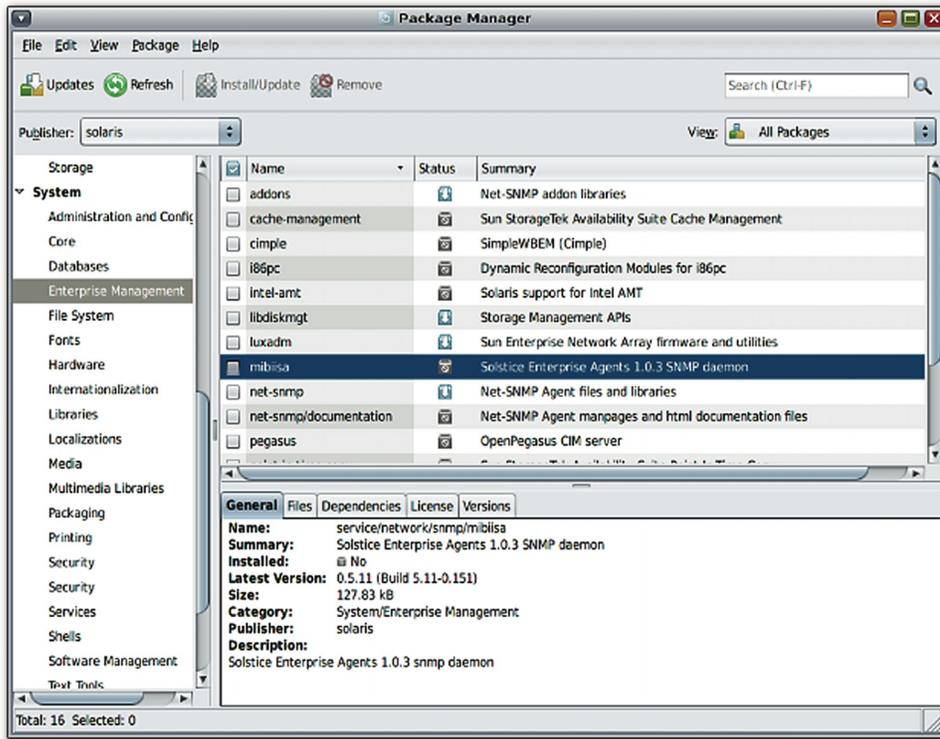


Figure 5. Package Manager in Oracle Solaris 11 Express.

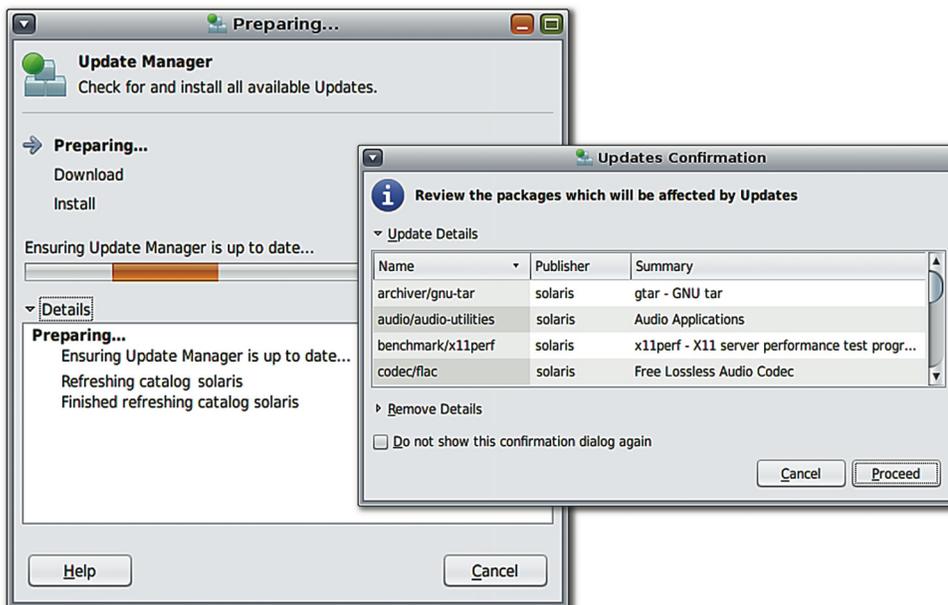


Figure 6. Update Manager in Oracle Solaris 11 Express.

## Upgrading Software on a System

In conjunction with the IPS packaging framework, Oracle Solaris 11 Express supplies a new methodology and tools to clone the active boot environment and subsequently use that image to upgrade the operating environment. Similar in concept to Live Upgrade in Oracle Solaris 10, upgrading in Oracle Solaris 11 Express takes advantage of underlying ZFS file system technology, using its native fast snapshot and clone capabilities to replicate the active operating system image.

When an administrator updates system software (via an “Update All” in Package Manager or Update Manager, or “`pkg image-update`”), Oracle Solaris 11 Express first clones the current boot environment and applies packaging changes to the clone. By default the clone is automatically activated on reboot. If a problem occurs, the administrator can easily roll back to the previous boot environment image. In this way, Oracle Solaris 11 Express provides an administrative safety net for OS upgrades and software changes, which helps to improve system and application availability. Because fast reboot is configured as the default, systems can switch to a new boot environment quickly, often within seconds.

## Managing Boot Environments

In Oracle Solaris 11 Express, the new `beadm (1M)` utility is used to manage boot environments and snapshots of system images (in this context a snapshot is a read-only, non-bootable image). Table 4 shows `beadm` commands for common management tasks.

**TABLE 4. BOOT ENVIRONMENT COMMANDS**

TASK	BEADM COMMAND
Create a boot environment.	<code>beadm create</code>
Make the specified boot environment active on the next reboot.	<code>beadm activate</code>
List information about boot environment(s).	<code>beadm list</code>
Destroy a boot environment or snapshot.	<code>beadm destroy</code>
Mount or unmount a boot environment at a mount point.	<code>beadm mount</code> or <code>beadm unmount</code>
Rename a boot environment.	<code>beadm rename</code>

Note that it is possible to create and mount an inactive boot environment and then update it:

```
$ pfexec beadm create Special
$ pfexec beadm mount Special /mnt
$ pfexec pkg -R /mnt install mpathadm
$ pfexec beadm unmount Special
$ pfexec beadm activate Special
$ pfexec init 6
```

This series of commands creates and mounts an inactive boot environment (`Special`) and then updates it by adding a new package. The boot environment is then unmounted, activated, and booted. (Note that only a user who has special privileges can use `pfexec` to execute the `beadm` command.)

## Boot Environments and Zones

There are important implications to understand when managing boot environments with zones (Oracle Solaris Containers). When a new boot environment is created, the cloned image includes definitions for non-global zones in the original environment. However, packages in these zones are *not* upgraded when the base environment image is upgraded. This provides flexibility to have different zones running at different package levels for test and development purposes. To update packages in non-global zones, it is necessary to log into each non-global zone and perform “Update All” operations there. Since administrative privileges for zones can now be delegated, a zone administrator can independently use `beadm` to create and roll back image snapshots created within a zone.

For more information on Boot Environments, see [Managing Boot Environments With Oracle Solaris 11 Express](#) and the man page `beadm (1M)`.

## Automating Installations of Multiple Systems in the Enterprise

In conjunction with ZFS root, SMF, and the new IPS packaging framework, Oracle Solaris 11 Express introduces a new paradigm for hands-free installations of multiple systems across the enterprise called the Automated Installer (AI). AI services help to lower the cost of deploying an Oracle Solaris-based software stack, replacing Oracle Solaris JumpStart in Oracle Solaris 10. The Automated Installer automates and batches installations based on customized, standardized system profiles called manifests. It offers a significant advantage of using networking protocols that are WAN-compatible (e.g., PXE/TFTP, HTTP, mDNS/DNS), providing greater operational flexibility.

An important advantage over Oracle Solaris JumpStart is simplicity – Automated Installer requires the setup of an installation server once, regardless of the number of clients that are installed, and no explicit setup is required for AI clients. (There is, however, a command to enable non-default customizations for clients, if desired.) AI client machines are installed according to manifests that define and match client characteristics. AI then performs installations using the network-aware Image Packaging System. Network-accessible or local package repositories make it easy for the installation service to locate software during client installation.

The Automated Installer helps to reduce the need for third party or customized extensions. With Oracle Solaris JumpStart, administrators often implemented post-installation scripts that added to the complexity and cost of automating installations. Instead, the Automated Installer can address many of these requirements by customizing configuration manifests on the front-end and by SMF service configurations that occur during the first system reboot.

Table 5 provides a basic comparison of Oracle Solaris JumpStart elements and Automated Installer tasks in Oracle Solaris 11. For example, XML-based manifests in AI replace JumpStart rules and profiles that govern how specific clients are installed and configured.

**TABLE 5. COMPARISON OF ORACLE SOLARIS JUMPSTART AND AI TASKS**

TASK	ORACLE SOLARIS JUMPSTART METHOD	AI METHOD
Installing clients	add_client on Oracle Solaris JumpStart server for each client.	installadm create-service command on AI install server to set up install service.
Installation configuration	<ul style="list-style-type: none"> <li>• Profile files.</li> <li>• sysidcfg(4) file.</li> <li>• Rules files.</li> </ul>	<ul style="list-style-type: none"> <li>• Automated Installer (AI) manifests, which define installation parameters (e.g., disk targets, repositories, packages, etc.) and information for post-install (e.g., timezone, root password, and initial user name).</li> <li>• Criteria manifests, which map the AI manifests to specific clients.</li> </ul>
Configure root password	Use the root_password keyword in a sysidcfg(4) file.	Configure root password in the AI manifest.
Upgrade systems	Specify upgrade for install_type.	Use pkg commands.
Install third-party software	Oracle Solaris JumpStart "finish" script.	Create an SMF service to run at first boot after AI install.

As Table 5 shows, there are two types of manifests: AI manifests and Criteria manifests. As an example, the Criteria manifest excerpt below specifies an installation profile for clients within the IP address range 10.6.68.1 to 10.6.68.200.

```
...<ai_criteria_manifest>
  <ai_criteria name="IPV4">
    <range>
      10.6.88.1
      10.6.68.200
    </range>
  </ai_criteria>
</ai_criteria_manifest>
```

The following AI manifest excerpt shows how packages can be specified for install and un-install:

```
... <ai_install_packages>
  <pkg name="entire"/>
  <pkg name="SUNWcsd"/>
  <pkg name="SUNWcs"/>
</ai_install_packages>
<ai_uninstall_packages>
  <pkg name="slim_install"/>
</ai_uninstall_packages>
```

The following AI manifest excerpt shows how system characteristics (such as default user name, passwords, timezone, and hostname) can be specified:

```
... <property_group name='ai' type='application'>
  <propval name='username' type='astring' value='jack' />
  <propval name='description' type='astring' value='default user' />
  <propval name='userpass' type='astring' value='9Nd/cwBcNWFZg' />
  <propval name='rootpass' type='astring' \
    value='$5$VgppCOxA$ycFmk5bugggSiaSR9niNCouC' />
  <propval name='timezone' type='astring' value='US/Pacific' />
  <propval name='hostname' type='astring' value='s11host1' />
</property_group>
```

## The Automated Installer Process

Much in the way Oracle Solaris JumpStart works when a client is booted, the Automated Installer begins the installation process when an AI client system boots. The AI client first gets an IP address and boot file location through DHCP. Note that the boot process for SPARC processor-based systems no longer uses Reverse ARP (RARP) protocol – instead, DHCP protocol is used regardless of the target machine architecture. Thus, there is no longer a need for different boot management processes for x86 and SPARC processor-based systems.

After the bootloader loads and the installation client boots, it fetches the specified AI manifest from the AI installation server using HTTP protocol. The AI manifest directs how to set up target disks, identifies package repositories to use, and defines which packages should be installed. It also supplies the initial user name, a root password, and a host name. The client then executes IPS packaging commands to install appropriate packages.

For more information on the Automated Installer, see the [Oracle Solaris 11 Express Automated Installer Guide](#) and the man page `installadm(1)`.

## Building a Customized Distribution Image

Oracle Solaris 11 Express includes a new tool called the Distribution Constructor that allows users to build an install image from IPS package repositories. The `distro_const(1M)` tool is a command-line tool that builds preconfigured, bootable Oracle Solaris 11 Express images. This tool takes an XML manifest file as input, and based on parameters specified in the manifest, builds an ISO image as output. Optionally, a USB or a Virtual Machine (VM) image can be created from the generated ISO image.

Similar to flash archives in Oracle Solaris 10, install images can be customized with additional drivers or services, and can be subsequently used with the Automated Installer or for interactive installations. Some typical use cases for the `distro_const (1M)` tool include:

- Setting up a complete distribution image or creating virtual machine images to expedite deployment. (Creating a “cookie cutter” image, such as a standardized Web server image or VM image, are typical customer use cases.)
- Installing a small number of physical machines.
- Creating a “rescue” media image.

Other use cases include those addressed today with flash archive images in Oracle Solaris 10.

An administrator should run Distribution Constructor on the targeted destination machine architecture (i.e., run `distro_const` on an x86 machine to create an image for x86 deployment, or on a SPARC machine to create an image for SPARC deployment). The Oracle Solaris 11 Express release supplies sample XML input manifest files with preset values.

Since the Distribution Constructor is implemented using ZFS technology, it innately provides the ability to checkpoint and resume at certain stages of the image-generation process. This checkpointing feature can help during the process of developing and debugging different installation images.

The tool includes finalizer scripts that customize a generic output image into a media-specific distribution (the default scripts generate ISO images for an x86 Slim CD, an x86 AI ISO image, or a SPARC AI ISO image). The user can then burn an ISO image or optionally create a USB image (by copying the image to a USB flash device with `usbcopy`).

For more information on the Distribution Constructor, see the [Oracle Solaris 11 Express Distribution Constructor Guide](#) and the man page `distro_const (1M)`.

## Managing Systems with Consolidated Workloads

To reduce the complexity of IT management and contain costs, many organizations consolidate applications, using virtualization technologies to isolate workloads and manage system resources more effectively. Oracle Solaris 10 introduced virtualization technology built into the operating system – known as Oracle Solaris Containers – which implement distinct system environments known as zones. Oracle Solaris 11 Express includes significant enhancements to zone administration and observability, helping administrators more efficiently manage consolidated and virtualized workloads.

## Delegated Zone Administration

The `zonecfg` command in Oracle Solaris 11 Express exposes delegated administration for zones. A new `zonecfg` resource type, `admin`, includes two new properties, `user` and `auths`:

```
# zonecfg -z myzone
zonecfg:myzone> add admin
zonecfg:myzone:admin> set user=zadmin
zonecfg:myzone:admin> set auths=login,manage
zonecfg:myzone:admin> end
zonecfg:myzone> commit
# cat /etc/user_attr | grep zadmin
zadmin:::type=role;auths=solaris.zone.login/myzone,
solaris.zone.manage/myzone;profiles=Zones Management
```

When zone administration responsibilities are delegated in this way, the zone administrator can then perform necessary administrative tasks within the zone, including creating and managing boot environment images with `beadm` (see page 10). By using ZFS clones and managing zone images, zone administrators can replicate and deploy zones quickly. A new command – `zonestat(1)` – also improves an administrator’s ability to observe resources within a zone. `Zonestat` gives memory, CPU, utilization, and per-zone resource breakdowns similar to other OS statistics tools, consolidating and presenting useful performance data for an administrator.

For more information about zones management, see [System Administration Guide: Oracle Solaris Zones, Oracle Solaris 10 Containers, and Resource Management](#) and the man pages on `zoneconfig(1M)` and `zonestat(1)`.

## Managing Virtualized Network Resources

Oracle Solaris 11 Express evolves the networking stack, adding virtualized resources and resource management. As Figure 7 shows, virtualization promotes effective resource sharing, prioritization, and control in consolidated server deployments. Each virtual stack can be assigned a priority and bandwidth capabilities on a shared Virtual Network Interface Controller (VNIC). This architecture allows administrators to manage bandwidth dynamically and isolate services in zones to help counter denial-of-service attacks.

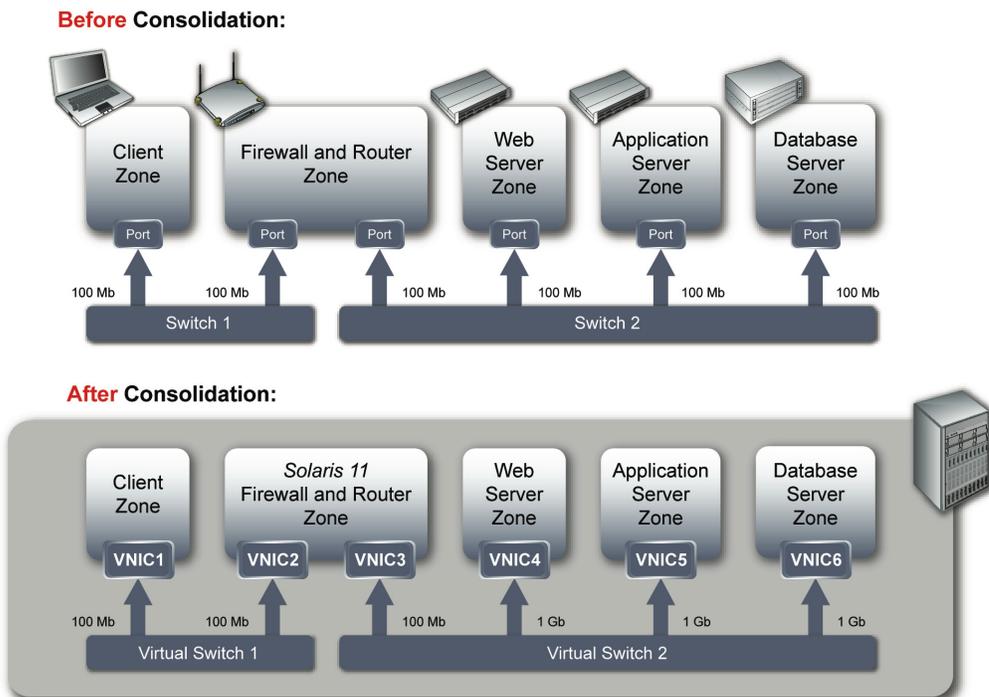


Figure 7. VNICs enable more effective isolation and resource control in consolidated environments.

The utility `dladm(1M)` is used to create and allocate bandwidth to VNICs. The command sequence below creates three VNICs with a maximum bandwidth of 100Mb and another VNIC, `vnic6`, with a maximum bandwidth of 1Gb. (`vnic4` and `vnic5` would be configured much like `vnic6`.) As shown in Figure 7, `vnic1` and `vnic2` share a single physical interface, `e1000g1`, and `vnic3` through `vnic6` share a second physical interface, `e1000g2`.

```
# dladm create-vnic -l e1000g1 vnic1
# dladm set-linkprop -p maxbw=100m vnic1
# dladm create-vnic -l e1000g1 -p maxbw=100m vnic2
# dladm create-vnic -l e1000g2 -p maxbw=100m vnic3
# dladm create-vnic -l e1000g2 -p maxbw=1g vnic6
# dladm show-vnic
```

LINK	OVER	SPEED	MACADDRESS	MACADDRTYPE	VID
vnic1	e1000g1	100	2:8:20:59:ef:a3	random	0
vnic2	e1000g1	100	2:8:20:9:25:45	random	0
vnic3	e1000g2	100	2:8:20:c:53:b8	random	0
vnic6	e1000g2	1000	2:8:20:7a:1d:d8	random	0

For more information, see [System Administration Guide: Oracle Solaris Zones, Oracle Solaris 10 Containers, and Resource Management](#).

## Configuring Network Resources

In addition to configuring virtual interfaces, Oracle Solaris 11 Express modifies how administrators configure datalinks, physical network interfaces, and IP addresses, simplifying these common tasks with easy-to-use utilities that offer consistent syntax, prevent needless service interruptions, and create configurations that can persist after reboots. With the `dladm(1M)` utility, administrators use a uniform syntax to configure network driver properties without disrupting other network connections. The `ipadm(1M)` command replaces the `ifconfig` command when configuring IP interfaces and addresses – unlike `ifconfig`, `ipadm` provides a means of implementing interface and address configurations that persist even after reboot. The example below shows how `ipadm` configures a new static IP address for the physical interface `e1000g3`.

```
# ipadm create-if e1000g3
# ipadm show-if e1000g3
IFNAME      STATE      CURRENT      PERSISTENT
e1000g3     down      bm-----46  -46
# ifconfig e1000g3
e1000g3: flags=1000842<BROADCAST,RUNNING,MULTICAST,IPv4> mtu 1500 index 3
        inet 0.0.0.0 netmask 0
        ether 0:15:17:af:e5:ea
# ipadm create-addr -T static -a 192.168.17.1/24 e1000g3/v4
# ifconfig e1000g3
e1000g3: flags=1000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4> mtu 1500 index 3
        inet 192.168.17.1 netmask ffffffff broadcast 192.168.17.255
        ether 0:15:17:af:e5:ea
# ipadm show-addr e1000g3/v4
ADDROBJ      TYPE      STATE      ADDR
e1000g3/v4   static   ok         192.168.17.1/24
```

Oracle Solaris 11 Express also improves the area of IP observability, allowing the administrator to use common packet sniffing tools such as `wireshark` and `snoop` to view IP traffic on both physical and virtual paths. Traffic can be observed at the IP layer, including traffic to and from specific zones.

### Redesigned IP Network Multipathing

For systems with multiple physical network interfaces on a particular LAN, IP network multipathing (IPMP) provides interface failure detection, transparent network failover, and packet load balancing. In Oracle Solaris 11, IPMP has been redesigned to enhance the administrative model and improve observability. An IPMP group (which has a set of associated IP addresses that are dynamically bound to a set of underlying physical interfaces) is represented by an IPMP interface. All IP administrative tasks (e.g., changes to routing tables, ARP tables, firewall rules, etc.) take effect on the IPMP group simply by referencing the IPMP interface. A new utility, `ipmpstat(1M)`, provides visibility into the IPMP subsystem.

For more information, see [Solaris 11 Express System Administration Guide: Network Services](#) and the man pages on `dladm(1M)`, `ipadm(1M)`, and `ipmpstat(1M)`.

## Managing Security

Today many organizations deploy Oracle Solaris 10 because of its ability to implement strict system security and protect valuable corporate assets and information. With a “secure-by-default” initial configuration, Oracle Solaris 11 Express continues to optimize security controls. This release supplies a number of security-related enhancements:

- **Root as a role.** As described previously, root is treated as a role rather than a user. During system installation, an initial user is defined. After an initial user login, a user with the appropriate privileges can subsequently assume the role of root using `su` (or perform administrative tasks after authentication using `sudo` or `pfexec`). Invoking administrative privileges generates a security-relevant event that can be logged and audited accordingly.
- **Encrypted ZFS datasets.** With on-disk encryption/decryption support and key management for ZFS datasets, Oracle Solaris 11 Express adds more exacting mechanisms for data protection. In the event of theft or in the case of untrusted paths to networked storage, encrypted ZFS datasets can help to safeguard data and prevent unauthorized access. The kernel implements raw encryption/decryption functions, which are applied to all data and file system metadata, including file owners, ACLs (Access Control Lists), file sizes, etc.
- **Trusted Platform Module (TPM) support.** TPM hardware devices are often embedded in systems to securely store certificates or encryption keys that help to perform platform authentication and/or attestation (a process that indicates that a server is trustworthy and has not been breached). Oracle Solaris 11 Express includes driver support for TPM chips. This TPM driver support complies with the Trusted Computer Group (TCG) 1.2 specification for TPM devices. In addition, Oracle Solaris 11 Express supplies a Trusted Software Stack and a PKCS#11 provider for the Oracle Solaris Cryptographic Framework, providing the tools to implement cryptographic operations on a secure TPM device. This release also includes management tools for the TPM and PKCS11 provider.
- **Enhancements to Oracle Solaris Trusted Extensions.** Oracle Solaris 11 Express introduces labeled IPsec and labeled ZFS datasets. In Multi-Level Secure (MLS) environments, sensitivity labels are applied to operating system resources for the purposes of granting access in conjunction with least privilege. In Oracle Solaris Trusted Extensions, the existing CIPSO trusted networking protocol assumes that the underlying network is secure and that CIPSO packet headers cannot be manipulated or observed while packets are in transit. Oracle Solaris 11 Express introduces labeled IPsec, permitting sensitivity labels to be associated with IPsec-protected traffic, which facilitates labeled networking over untrusted networks. Oracle Solaris 11 Express can also apply sensitivity labels to ZFS datasets, further securing data assets in MLS deployments.

For more information, see [Solaris 11 Express System Administration Guide: Security Services](#) and [Solaris 11 Express System Administration Guide: Network Services](#).

## Managing Data

Oracle Solaris 11 Express provides changes and enhancements that impact data management:

- ZFS is now the default file system, and the implementation adds de-duplication capabilities to conserve storage consumption.
- The addition of COMSTAR (Common Multiprotocol SCSI Target) technology means that any Oracle Solaris 11 Express server can be easily configured as a SCSI target, allowing it to provide network-accessible storage services to other hosts.
- CIFS support integrated with ZFS and NFS, which enhances file sharing with Windows systems.

### ZFS Enhancements

First available in Oracle Solaris 10, ZFS is a 128-bit file system that offers dramatic advances in data management and 64-bit checksums for data integrity. Because ZFS relies on the concept of virtual storage pools, it enables near-zero administration since pools can grow and shrink as needed. Snapshot and clone capabilities, which rely on the underlying copy-on-write transactional model, improve reliability and lay the groundwork for new software management features in Oracle Solaris 11 Express.

For this reason, ZFS is now the default file system in Oracle Solaris 11 Express. Although UFS is still available for compatibility, administrators must deploy ZFS for root file systems – this is required to perform software maintenance and safe upgrades in Oracle Solaris 11 Express.

Oracle continues to innovate ZFS technology in Oracle Solaris 11 Express, adding ZFS de-duplication. De-duplication detects and removes redundant data from ZFS file systems. If a ZFS file system has the dedup property enabled, duplicate data blocks are removed synchronously. As a result, the file system stores only unique data.

In the following commands, a large file is copied twice on the ZFS file system `mpool`. However, ZFS detects the copies and conserves storage space through its de-duplication capabilities (note how the level of de-duplication increases from 1 to 2.99 in the output below).

```
# zfs create -o dedup=on mpool/ddpfs
# cp big_file /mpool/ddpfs/1
# zpool list
NAME      SIZE  ALLOC  FREE   CAP  DEDUP  HEALTH  ALTROOT
mpool    250M  109M   141M   43%  1.00x  ONLINE  -
rpool    232G  144G   88.4G   61%  1.02x  ONLINE  -
# cp big_file /mpool/ddpfs/2
# cp big_file /mpool/ddpfs/3
# zpool list
NAME      SIZE  ALLOC  FREE   CAP  DEDUP  HEALTH  ALTROOT
mpool    250M  112M   138M   44%  2.99x  ONLINE  -
rpool    232G  144G   88.2G   61%  1.02x  ONLINE  -
```

## COMSTAR

New in this release, COMSTAR (Common Multiprotocol SCSI Target) technology allows network file sharing, similar to NFS and CIFS, but for raw block-device access via iSCSI or SAN. This technology enables any Oracle Solaris 11 Express host to become a SCSI target, allowing it to be accessed over a storage network by a variety of initiator hosts. COMSTAR supplies a software framework that makes it possible for all SCSI device types (tape, disk, etc.) to connect to a transport protocol (such as Fibre Channel, iSCSI, etc.) and provide network device access. In this way, virtual machines can share image files, for example, or share access to a database.

The COMSTAR implementation includes these features:

- Extensive LUN masking and mapping functions that help to simplify device access.
- Multipathing across different transport protocols to comply with SCSI storage interface standards.
- Multiple parallel transfers per SCSI command to enhance overall performance.
- A scalable design that supports on-demand provisioning (dynamically growing and shrinking storage as needed).
- Compatibility with generic Host Bus Adapters (HBAs).

Oracle Solaris 11 Express supports a number of protocols, including iSCSI Extensions for RDMA (iSER) and SCSI RDMA Protocol (SRP) for hosts that include an InfiniBand Host Channel Adapter, iSCSI, and Fibre Channel over Ethernet (FCoE). DTrace probes have also been added to COMSTAR in the SCSI Target Mode Framework (STMF) and SCSI Block Device (SBD).

## Enhanced CIFS

Oracle Solaris 11 Express provides in-kernel CIFS support for seamless file sharing with Windows environments. The CIFS service also includes new features, such as host-based access control (allowing a CIFS server to restrict access to specific clients according to IP address), ACLs on shares, and client-side caching of offline files with synchronization on reconnect.

For more information, see [System Administration Guide: Devices and File Systems](#).

## Managing Printing

Available in several other modern OS environments, the Common UNIX Printing System (CUPS) service is now part of the Oracle Solaris 11 Express distribution. CUPS is the default print service, although LP print services can also be configured. Additionally, Oracle Solaris 11 Express automatically discovers locally attached or network-attached printers.

For more information, see [System Administration Guide: Printing](#).

## Using Oracle Solaris 11 Express

For desktop users, Oracle Solaris 11 Express offers a state-of-the-art GNOME desktop. The desktop includes the innovative Time Slider tool (see Figure 8). Integrated with the File Browser, Time Slider supports file and directory recovery, which is made possible through native snapshot and clone capabilities in ZFS. A user can click in Time Slider to snapshot a home directory and later revert back to it if need be. As Figure 8 shows, Time Slider lists changes between snapshots, allowing users to view file and directory differences between snapshots.

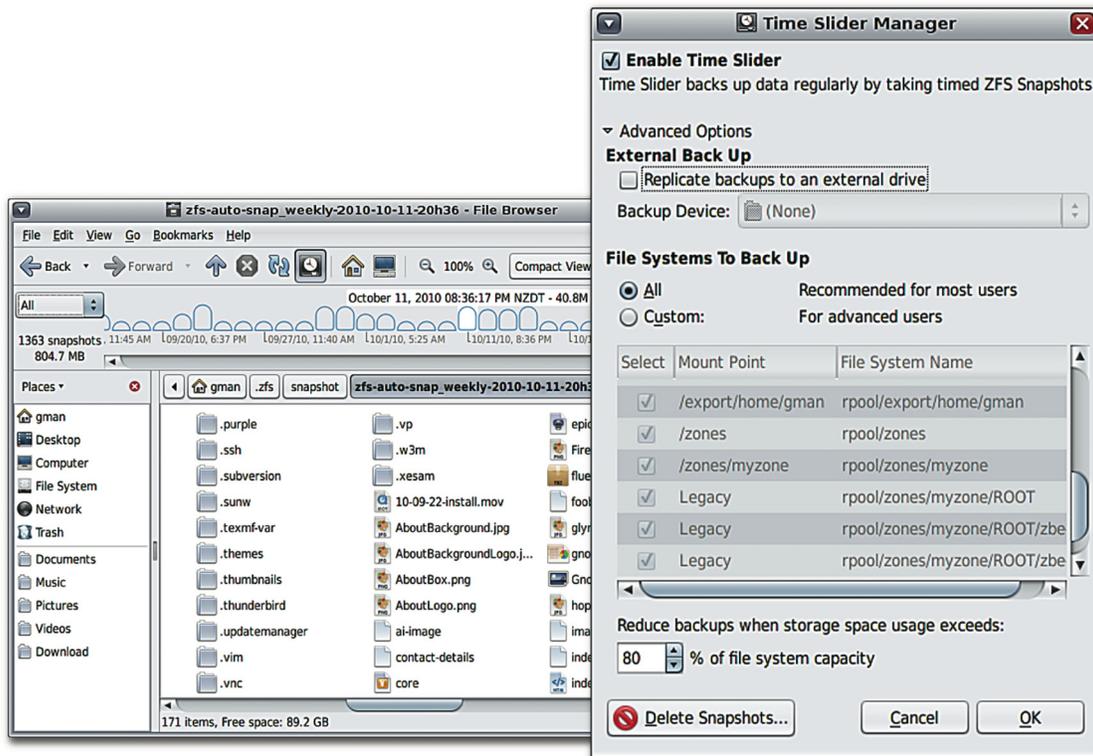


Figure 8. Time Slider.

There are other changes in Oracle Solaris 11 Express that impact the user experience, notably:

- GNU user environment and tools. The default user path places `/usr/gnu/bin` before `/usr/bin`, giving users a familiar GNU-like environment by default.
- Default shell changes. `Bash (1)` is now the default interactive shell, and `ksh93 (1)` replaces `ksh (1)` as the default system shell.
- The path to man pages. The `man (1)` command figures out the appropriate `$MANPATH` based on `$PATH`. `MANPATH` may be set explicitly but in most cases it is not necessary.
- During the x86 desktop boot process, a user can switch from the graphical boot screen to the text boot screen by pressing any key after the graphical boot screen appears. If system startup is not proceeding normally, the text screen may contain messages that can help to troubleshoot a particular problem.

For more information, see [What's New in Oracle Solaris 11 Express](#).

## Conclusion

The Oracle Solaris 11 Express release forms a strong foundation for the entire Oracle software stack, allowing customers to deploy enterprise applications with confidence. Because the operating system sits between system hardware and business-critical applications, its features are at a critical junction that can appreciably impact application scalability, efficiency, security, and availability. The Oracle Solaris 10 release boasts a number of innovations that have long proven successful in deploying and optimizing enterprise applications. Oracle Solaris 11 Express extends those technologies, adding new functionality that helps to simplify administration, secure data and applications, improve system resource utilization, and promote business continuity.

Oracle Solaris 11 Express is a production-capable release that administrators can download and deploy now, with full support available as an option from Oracle. To get the release, visit the Oracle Solaris 11 Express [download site](#) and start learning first-hand about innovations in this new release that can support strategic applications for your desktop and enterprise users.

## References

For more information on the Oracle Solaris 11 Express and related topics, please see the references listed throughout this paper and in Table 6.

**TABLE 6. REFERENCES FOR MORE INFORMATION**

REFERENCE	WEB SITES
Downloads	<a href="http://www.oracle.com/technetwork/server-storage/solaris11/downloads/index.html">http://www.oracle.com/technetwork/server-storage/solaris11/downloads/index.html</a>
"What's New in Oracle Solaris 11 Express" paper	<a href="http://www.oracle.com/technetwork/server-storage/solaris11/documentation/solaris-express-whatsnew-201011-175308.pdf">http://www.oracle.com/technetwork/server-storage/solaris11/documentation/solaris-express-whatsnew-201011-175308.pdf</a>
Oracle Solaris 11 Express main product page	<a href="http://www.oracle.com/technetwork/server-storage/solaris11/index.html">http://www.oracle.com/technetwork/server-storage/solaris11/index.html</a>
Oracle Solaris 11 Express Documentation	<a href="http://www.oracle.com/technetwork/server-storage/solaris11/documentation/index.html">http://www.oracle.com/technetwork/server-storage/solaris11/documentation/index.html</a>
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Oracle Solaris 11 Express support	<a href="http://www.oracle.com/us/support/software/premier/index.html">http://www.oracle.com/us/support/software/premier/index.html</a>
Oracle Solaris forum	<a href="http://forums.oracle.com">http://forums.oracle.com</a>



Introducing Oracle Solaris 11 Express – What's  
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