Transitioning From Oracle® Solaris 10 to Oracle Solaris 11.3

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Using This Documentation

- **Overview** – Describes topics for transitioning from Oracle Solaris 10 to Oracle Solaris 11 releases.
- **Audience** – Technicians, system administrators, and authorized service providers.
- **Required knowledge** – Basic knowledge of Oracle Solaris.

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♦ ♦ ♦ CHAPTER 1

About Transitioning From Oracle Solaris 10 to an Oracle Solaris 11 Release

This chapter provides overview information about transitioning from Oracle Solaris 10 to an Oracle Solaris 11 release.

The following topics are covered in this chapter:

Welcome to Oracle Solaris 11.3

Oracle Solaris 11 is an enterprise-level operating system (OS), as well as a complete cloud platform. The latest release, Oracle Solaris 11.3, is an integral part of Oracle's combined hardware and software portfolio. If you are moving from Oracle Solaris 10 to an Oracle Solaris 11 release, you might have some questions. The purpose of this guide is to provide answers to some of those questions.

Note - This book contains cumulative information for anyone who is transitioning from Oracle Solaris 10 to an Oracle Solaris 11 release. For specific information about which features are supported in a particular Oracle Solaris 11 release, see the product documentation.

Most Oracle Solaris 10 applications are known to work on Oracle Solaris 11. You can run supported applications *as is*. To determine the readiness of Oracle Solaris 10 applications to run on Oracle Solaris 11, use the Oracle Solaris 11 compatibility checking tool at `https://www.oracle.com/technetwork/server-storage/solaris11/downloads/preflight-checker-tool-524493.html`.

Alternatively, you can run applications that rely on features that are excluded from Oracle Solaris 11 in an Oracle Solaris 10 virtual environment. See Chapter 10, “Managing Virtualization Features”.

See also `https://www.oracle.com/technetwork/articles/systems-hardware-architecture/o10-015-s11-isv-adoption-198348.pdf`.

This guide does not provide information about every new Oracle Solaris 11 feature, nor does it mention every feature that is excluded from Oracle Solaris 11.

- For more details about new features, see *What’s New in Oracle Solaris 11.3*.
- For more details about excluded features, see `https://www.oracle.com/technetwork/systems/end-of-notices/index.html`.
- For information about updating your system to Oracle Solaris 11.3, see *Updating to Oracle Solaris 11.3*.
- For information about Oracle's Sun hardware platforms and any corresponding Oracle Solaris operating system requirements, see `https://www.oracle.com/technetwork/systems/software-stacks/stacks/index.html`.

Oracle Solaris 10 and Oracle Solaris 11 Feature Comparison

The following table compares Oracle Solaris 10 features to Oracle Solaris 11 features.

Note - Features are listed in alphabetical order.

TABLE 1 Oracle Solaris 10 Features Compared to Oracle Solaris 11 Features

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
x86: boot loader (GRUB)	GRUB Legacy (0.97)	GRUB 2 “GRand Unified Bootloader Changes” on page 121

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
boot loader (administration)	**SPARC:** `installboot` **x86:** `installgrub`	`bootadm install-bootloader` (SPARC and x86)
Booting (from a root device)	From a ZFS, UFS, or Solaris Volume Manager root device	From a ZFS root file system "Boot, Recovery, Platform, Hardware, and Disk Labeling Changes" on page 120
Booting (from the network)	**SPARC:** From the OpenBoot PROM (OBP) `ok` prompt: `boot net[:dhcp]` or `boot net[:rarp]` **x86:** Requires a DHCP server that supports a Preboot Execution Environment (PXE) boot from the network	**SPARC:** `boot net:dhcp` **x86:** PXE boot process has changed for UEFI firmware *only* "Booting Systems With UEFI and BIOS Firmware From the Network" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*
Booting (recovery)	**SPARC:** From the OBP `ok` prompt: `boot -F failsafe` **x86:** Select the failsafe boot entry in the GRUB menu at boot time	Failsafe mode no longer supported on x86 and SPARC platforms. "Boot, Recovery, Platform, Hardware, and Disk Labeling Changes" on page 120 Oracle Solaris Unified Archives "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129
Crash dump directory location	`/var/crash/`*system-name*	`/var/crash`
Database management system (MySQL)	Release series 5.1	Release series 5.1 and release series 5.5 Upgrade from MySQL 5.1 to 5.5. See "Update from MySQL 5.1 to MySQL 5.5" in *Oracle Solaris 11.3 Release Notes*.
Desktop environment	Common Desktop Environment (CDE) (default) and GNOME 2.6 (optional)	Oracle Solaris Desktop (GNOME 2.30) Chapter 12, "Managing the Oracle Solaris 11 Desktop"
Disk labeling	UFS root disk is SMI (VTOC); UFS non-root disk is SMI or EFI ZFS root disk is SMI (VTOC); ZFS non-root disk is SMI or EFI (recommended)	**x86 and SPARC with GPT-aware firmware:** ZFS root disk is EFI (GPT). **SPARC:** ZFS root disk is SMI (VTOC) **SPARC and x86:** ZFS non-root disk is SMI or EFI (recommended).

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
Ensuring system is configured securely	Solaris Security Toolkit (SST) `netservices` limited	`sysconfig` profiles Secure by Default (SBD) `compliance` command
File systems (default)	ZFS, UFS, or Solaris Volume Manager root file systems	ZFS root file system (default) Chapter 5, “Managing File Systems”
x86: Firmware support	BIOS	UEFI and BIOS Chapter 3, “Managing Devices”
GRUB configuration file (default)	`menu.lst`	`grub.cfg` “GRand Unified Bootloader Changes” on page 121
GRUB configuration file (custom)	`menu.lst`	`custom.cfg`
GRUB password protection	Not available	Available (starting with Oracle Solaris 11.3), there is a password protection option for GRUB 2 menu loading, menu entry modification, and menu entry booting. “GRand Unified Bootloader Changes” on page 121
Installation (graphical user interface (GUI))	GUI installation program on DVD or CD	Live Media (x86 only)
Installation (interactive text)	Interactive text installation and interactive text installer for ZFS root pools	Text installer (stand-alone and network installation)
Installation (automated)	JumpStart feature of Oracle Solaris 10	Automated Installer (AI) feature of Oracle Solaris 11 Oracle VM Manager Ops Center
Installation (automated client configuration)	JumpStart profile files	AI manifests
Installation (other)	Oracle Solaris Flash Archive installation	Oracle Solaris Unified Archives “System Recovery and Cloning With the Oracle Solaris Unified Archives Feature” on page 129
Internationalization and localization configuration	`localeadm`	`nlsadm` “Internationalization and Localization Changes” on page 132
Java version (default)	Java 6	Java 8
Network administration (fixed mode)	`ifconfig`	`dladm` for datalinks, `ipadm` for IP configuration

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
	Edit `/etc/hostname.*` `ndd` for configuring protocols (tunables)	Chapter 7, "Managing Network Configuration" and `ifconfig(5)`
Network administration (reactive mode)	Not applicable	`netcfg` and `netadm` Chapter 7, "Managing Network Configuration"
Network administration (DHCP)	Sun DHCP and other name services configuration	ISC DHCP and legacy Sun DHCP

Network administration (IP network multipathing (IPMP))	`ifconfig`, `plumb`, and `umplumb`	`dladm`, `ipadm`
		
		`ifconfig(5)`

Network administration (TCP/IP properties or tunables)	`ndd`
	
	`driver.conf`
		`dladm` and `ipadm`
		
		"Comparing the `ndd` Command to the `ipadm` Command" on page 96 and "Comparing the `ndd` Command and `driver.conf` Configuration to the `dladm` Command" on page 98

Network administration (wireless)	`wificonfig`	**Fixed mode:** `dladm` and `ipadm` **Reactive mode:** `netcfg`, and `netadm` **From the desktop:** Network administration GUI
Packaging (software management)	SVR4 package and patch commands	IPS `pkg(1)` commands and utilities
Print service (default)	LP print service, `lp` print commands, Solaris Print Manager GUI	CUPS "Printer Configuration and Management Changes" on page 130
Security management	`root` as a system account	`root` as a role Chapter 9, "Managing Security"
Sun Oracle server management	**SPARC and x86**: Oracle Hardware Management Pack: a set of commands and agents for managing Sun Oracle servers (packages available as a separate download)	Oracle Hardware Management Pack: a set of commands and agents for managing Sun Oracle servers (packages are included, starting with Oracle Solaris 11.2) `https://www.oracle.com/technetwork/documentation/sys-mgmt-networking-190072.html#ohmpsol`
System clustering	Oracle Solaris Cluster 3.3	Oracle Solaris Cluster 4

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
System configuration and reconfiguration	`sysidtool`, `sys-unconfig`, `sysidconfig`, and `sysidcfg`	`sysconfig`, SCI tool, SC profiles
System configuration (Oracle Solaris kernel configuration)	Add to `/etc/system`	Add to `/etc/system` and files within `/etc/system.d`
System configuration (naming services)	Configured in various files within `/etc` and `/var`	Managed by Service Management Facility (SMF) commands
System configuration (setting host name)	Edit `/etc/nodename`	`hostname` command "System Configuration Changes" on page 109
System management (centralized)	All versions of Ops Center support Oracle Solaris 10	`https://docs.oracle.com/cd/E27363_01/doc.121/e37545/toc.htm#OCUPW101`.
System recovery and cloning (automated)	Oracle Solaris Flash Archive feature	Oracle Solaris Unified Archives "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129
System registration and service request support	Auto Registration feature Oracle Configuration Manager (starting with Oracle Solaris 10 1/13)	Oracle Configuration Manager and the Oracle Auto Service Request utility
System upgrade and BE management	`lu` and SVR4 package commands	`pkg` commands `beadm` for managing boot environments Chapter 6, "Managing Software and Boot Environments"
User account management	`useradd`, `usermod`, `userdel`, `groupadd`, `groupmod`, `groupdel`, `roleadd`, `rolemod`, and `roledel` Solaris Management Console GUI and equivalent command-line	`useradd`, `usermod`, `userdel`, `groupadd`, `groupmod`, `groupdel`, `roleadd`, `rolemod`, and `roledel` User Manager GUI "Commands and Tools for Managing User Accounts" on page 157
User environment management	Korn shell (`ksh`) `MANPATH` variable required	**Default shell:** `ksh93` **Default** `ksh` **path:** `/usr/bin/ksh`; `/bin/sh` is also `ksh93` **Default interactive shell:** `bash`; default `bash` path: `/usr/bin/bash` `MANPATH` variable no longer required
ZFS root pool disk (SPARC and x86)	Root pool disk requires SMI (VTOC) disk label and a slice 0	"ZFS Root Pool Disk and Boot Administration" on page 49

Feature or Command	Oracle Solaris 10	Oracle Solaris 11
Zones environment	Oracle Solaris 10 branded zones, legacy branded zones	Supported Oracle Solaris 10 and Oracle Solaris 11 zones features and Oracle Solaris Kernel Zones (`solaris-kz` branded zones), starting with Oracle Solaris 11.2

Removal of Legacy System Management Commands, Files, and Services

The following table lists (in alphabetical order) the commands, files, and services that are deprecated or have been removed.

TABLE 2 Legacy System Management Commands, Files, and Services

Legacy Command, File, or Service	Replacement Command, File, or Service	For More Information
`bsmconv` and `bsmunconv`	`audit`	`audit`(1M)
`crypt` and `des`	`encrypt`	`encrypt`(1)
`/etc/defaultrouter` (deprecated)	`route`	`route`(1M)
`graph` and `spline`	`gnuplot`	`gnuplot`(1) **Note -** Install the `image/gnuplot` package.
SPARC: `installboot` **x86:** `installgrub` (deprecated and should only be used to install boot blocks on systems that support GRUB Legacy)	`bootadm install-bootloader` (SPARC and x86)	"ZFS Root Pool Disk and Boot Administration" on page 49
`localeadm`	`nlsadm` command	"Internationalization and Localization Changes" on page 132
Print commands: `download`, `lpfilter`, `lpforms`, `lpget`, `lpset`, `lpsched`, `lpshut`, `lpsystem`, `lpusers`, `printmgr` (launches Solaris Print Manager), `print-service`, and `ppdmgr`	`cancel`, `cupsaccept`, `cupsreject`, `cupsdisable`, `cupsenable`, `lp`, `lpadmin`, `lpc`, `lpinfo`, `lpmove`, `lpoptions`, `lpq`, `lpr`, `lprm`, `lpstat`, and `system-config-printer` (launches CUPS Print Manager)	"Printer Configuration and Management Changes" on page 130
Print (LP) files and descriptions: ■ `~/.printers` ■ `/etc/printers.conf` ■ `/etc/lp/printers` ■ `/var/spool/lp`	**CUPS print files and descriptions**: ■ `~/.cups/lpoptions` ■ `/etc/cups/printers.conf` ■ `/etc/cups` ■ `/var/spool/cups`	`lpoptions`(1)

Legacy Command, File, or Service	Replacement Command, File, or Service	For More Information
■ /var/lp/logs	■ /var/log/cups	
Legacy SMF print services: ■ svc:/application/print/ppd-cache-update:default ■ svc:/application/print/server:default ■ svc:/application/print/rfc1179:default ■ svc:/network/device-discovery/printers:snmp ■ svc:/application/print/ipp-listener:default ■ svc:/application/print/service-selector:default **Replacement SMF print services:** ■ svc:/application/cups/scheduler ■ svc:/application/cups/in-lpd		"Printer Configuration and Management Changes" on page 130
pmconfig and /etc/power.conf	poweradm	poweradm(1M)
rdist	rsync or scp	rsync(1) and scp(1)
rstart and rstartd	ssh	ssh(1)
listen, nlsadmin, pmadm, sac, sacadm, saf, and ttyadm /usr/include/listen.h, getty, /usr/lib/saf/nlps_server, /var/saf, /etc/saf, ttymon (sac and getty modes *only*), and ports (sac functionality)	ttymon express mode is still supported by the following SMF services: ■ svc:/system/console-login:terma ■ svc:/system/console-login:termb	"System Console and Terminal Services Changes" on page 117
Network SMF services: svc:/network/physical:default svc:/network/physical:nwam (deprecated in Oracle Solaris 11, but the service is still listed in the output of the svcs -a command)	svc:/network/physical:default	Chapter 7, "Managing Network Configuration"
smosservice and smdiskless	No replacement available	Not applicable
sysidtool, sys-unconfig, and sysidcfg	sysconfig, SCI tool, and SC configuration through profiles	"System Configuration Tools Changes" on page 118
User account management: Solaris Management Console GUI, smc, smuser, smgroup, and passmgmt	useradd, usermod, userdel, groupadd, groupmod, groupdel, roleadd, rolemod, roledel **Starting with Oracle Solaris 11.1:** User Manager GUI	"Managing User Accounts in Oracle Solaris" on page 158
vold daemon	volfs and rmvolmgr	Chapter 3, "Managing Devices"

For more information about legacy commands that are no longer supported, see https://www.oracle.com/technetwork/systems/end-of-notices/index.html.

Transitioning an Oracle Solaris 10 System to an Oracle Solaris 11 Release

Keep the following key points in mind when transitioning from Oracle Solaris 10 to an Oracle Solaris 11 release:

- No upgrade methods or tools are available for transitioning from Oracle Solaris 10 to an Oracle Solaris 11 release. You cannot use an installer to upgrade from Oracle Solaris 10 to Oracle Solaris 11. You must perform a fresh installation by using one of the installation options that are described in this chapter.

  However, you can migrate your Oracle Solaris 10 OS instances or zones and your data to an Oracle Solaris 11 system. For more information, see Table 3, "Oracle Solaris 11 Transition Tools and Features," on page 21.
- The following Oracle Solaris 10 installation features are not available in an Oracle Solaris 11 release: the Oracle Solaris installation upgrade option, the Oracle Solaris Flash Archive installation method, JumpStart, and the Oracle Solaris Live Upgrade feature (`lu` suite of commands).
- The Automated Installer (AI) replaces JumpStart and the `beadm` utility provides similar functionality to the `lu` commands. See "Transitioning From JumpStart to AI" on page 34 and "Tools for Managing Boot Environments" on page 79.
- The Oracle Solaris System Archive and Cloning feature provides functionality that is similar to the Oracle Solaris Flash Archive installation method. See "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129.
- Oracle Solaris 11 includes the Image Packaging System (IPS), which is a different mechanism than the legacy SVR4 package commands that are used in Oracle Solaris 10 and previous releases. See Chapter 6, "Managing Software and Boot Environments".

The following table describes the tools and features that are available for transitioning to an Oracle Solaris 11 release.

TABLE 3 Oracle Solaris 11 Transition Tools and Features

Tool or Feature	Description	For More Information
JumpStart Migration Utility (`js2ai`)	Used to convert Oracle Solaris 10 JumpStart rules, profiles, and `sysidcfg` file to a format that is compatible with AI manifest entries.	*Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.3 Automated Installer*

Tool or Feature	Description	For More Information
ZFS shadow migration feature	Used to migrate data from an existing file system to a new file system.	Chapter 4, “Managing Storage Features”
Oracle Solaris 11 support for Oracle Solaris 10 zones	Used to migrate your Oracle Solaris 10 application environments to an Oracle Solaris 11 system.	Chapter 10, “Managing Virtualization Features”
NFS file sharing and pool migration	Used to access shared files from an Oracle Solaris 10 system on an Oracle Solaris 11 system. Also used to import a ZFS storage pool from an Oracle Solaris 10 system into an Oracle Solaris 11 system.	Chapter 5, “Managing File Systems”

Installation Tools and Methods

The following installation methods are available:

- **x86: GUI installation with the Live Media** – You can use the GUI installer to install Oracle Solaris 11 on x86 platforms *only*. The GUI installer is capable of functioning with a minimum of 1.5 GB of memory. The exact minimum requirement varies, depending on system specifications. See “Installing Oracle Solaris by Using Installation Media” on page 32 for details.
- **Interactive text installation (from media or over a network)** – You can use the text installer to install Oracle Solaris 11 on SPARC and x86 based systems, from media or over a network.
- **Automated installation on single or multiple systems** – The Automated Installer (AI) installs Oracle Solaris 11 on a single client system or multiple client systems from an installation server on a network. Similar to JumpStart, AI provides a hands-free installation. You can also perform automated installations that boot from media. See “Installing Oracle Solaris by Using AI” on page 34.

  AI also supports the installation of zones. See “Oracle Solaris Zones Features” on page 150.
- **Customized installation image creation with the Distribution Constructor** – The Distribution Constructor tool creates preconfigured installation images. See *Creating a Custom Oracle Solaris 11.3 Installation Image*.

The following installation tools and methods are no longer available:

- **Oracle Solaris Flash Archive Installation** – You can use the Oracle Solaris Unified Archives feature to perform system cloning and recovery operations. Oracle Solaris Unified Archives are system archives that can contain one or more archived instances of the OS.

Each instance is an independently referenced system. See “System Recovery and Cloning With the Oracle Solaris Unified Archives Feature” on page 129.

- **JumpStart feature of Oracle Solaris** – AI replaces JumpStart in Oracle Solaris 11. See “Installing Oracle Solaris by Using AI” on page 34.
- **Oracle Solaris Live Upgrade feature** – The suite of commands (`lu`) that are part of the Oracle Solaris Live Upgrade feature are not supported. The Oracle Solaris `pkg` commands provide similar capability. For additional information about using the `beadm` command to manage boot environments in Oracle Solaris 11, see “Tools for Managing Boot Environments” on page 79.

See Chapter 2, “Transitioning to an Oracle Solaris 11 Installation Method”.

Software Management Features

The Oracle Solaris 11 software is distributed as IPS packages and many applications are available as IPS packages. After you install the OS, you can access *package repositories* to install additional or updated software packages on your system. With IPS commands, you can list, search, install, update, and remove software packages.

Software management includes the following components:

- **IPS command-line utilities** – IPS includes `pkg` commands that install and manage packages from the command line. IPS commands also enable you to manage package publishers and copy or create package repositories.
- **IPS repositories** – An *IPS repository* is a location from which you can install software packages.

Note - No upgrade path from Oracle Solaris 10 to Oracle Solaris 11 is available. You must perform a fresh installation. Review the migration features in Table 3, “Oracle Solaris 11 Transition Tools and Features,” on page 21. However, you can use the `pkg update` command to update from one Oracle Solaris 11 version to a newer Oracle Solaris 11 version.

See Chapter 6, “Managing Software and Boot Environments”.

Networking Features

The following key feature changes are related to network administration:

- **Generic datalink names** – Oracle Solaris 11 assigns generic names to each datalink on a system by using the `net0`, `net1`, `net`*N* naming convention. See Chapter 2, “Administering

Datalink Configuration in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

- **Naming and directory services configuration** – This configuration is managed through SMF rather than by editing various files within the `/etc` directory, as in Oracle Solaris 10 and previous releases. See "Configuring Naming and Directory Services" on page 104.
- **Network administration commands** – The following three commands are primarily used to manage persistent network configuration:
  - `dladm` command – Manages datalink configuration, both physical and other types of datalinks such as aggregations. The `dladm` command also replaces the `ndd` command and `driver.conf` file for configuring certain network properties and parameters (tunables).
  - `ipadm` command – Creates persistent configuration of IP interfaces and addresses. This command effectively replaces the `ifconfig` command for IP configuration. See the `ifconfig(5)` man page. The `ipadm` command also replaces the `ndd` command for configuring certain network properties and parameters (tunables). See Chapter 5, "Internet Protocol Suite Tunable Parameters" in *Oracle Solaris 11.3 Tunable Parameters Reference Manual*.
  - `route` command – Configures persistent routes. This command replaces the `/etc/defaultrouter` file for managing a system route configuration. The `/etc/defautrouter` command is deprecated in Oracle Solaris 11.

    See "Network Administration Command Changes" on page 91.
- **Network security features** – Oracle Solaris provides several new security features, as well as enhancements to several existing security features. See "Network Security Features" on page 140.
- **Network virtualization features** – Oracle Solaris 11 provides several network virtualization features that you can use to promote high availability, manage network resources, and improve overall network performance. Some of these features include aggregations, bridging technologies, virtual local area networks (VLANs), virtual network interface cards (VNICs), and the Elastic Virtual Switch (EVS) feature. See "Network Virtualization and Advanced Networking Features" on page 86.

See Chapter 7, "Managing Network Configuration".

System Configuration and SMF Features

The following system configuration and SMF feature changes have been made:

- **Oracle Auto Service Request utility** – Customers who have a valid My Oracle Support account to automatically log service requests can use this utility. See "System Registration and Customer Support Changes" on page 119.

- **Periodic tasks** – Instead of using the `cron` command, you can alternatively create a scheduled service to run system configuration tasks periodically. See Chapter 3, "Creating a Service to Run Periodically" in *Developing System Services in Oracle Solaris 11.3*.
- **SMF layers** – This feature enables you to record the source of properties, property groups, instances, and services. You can use this information to determine which settings are administrative customizations versus those settings that were provided in an SMF profile or delivered by an SMF manifest. See "SMF Administrative Changes" on page 114 and *Developing System Services in Oracle Solaris 11.3*.
- **SMF manifest creation tool** – You can use the `svcbundle` command to generate SMF manifests, as well as profiles. See `svcbundle`(1M).
- **SMF stencil services** – If your application cannot use `libscf` library interfaces to read properties, you can use a stencil to create a configuration file. A *stencil service* creates configuration files by using a stencil file and property values that are defined within the stencil service. For more details, see Chapter 6, "Using a Stencil to Create a Configuration File" in *Developing System Services in Oracle Solaris 11.3*.
- **System Configuration Interactive (SCI) utility** – Centralizes configuration information through SMF. The `sysconfig` utility replaces the `sys-unconfig` and `sysidtool` utilities that are used in Oracle Solaris 10. See "System Configuration Tools Changes" on page 118.
- **System registration With Oracle Configuration Manager** – Collects configuration information and then anonymously uploads it to the Oracle repository during the first reboot of a system after an installation. See "System Registration and Customer Support Changes" on page 119.

See Chapter 8, "Managing System Configuration".

Storage and File Systems Features

The following key feature changes are related to storage and file systems management:

- **Device management** – New commands are available and existing commands have been updated to help you locate storage devices by their physical locations.
- **Storage solutions** – Oracle's Sun ZFS Storage Appliance provides a low-cost storage solution and simplified administration with a browser-based management and monitoring tool. You use the appliance to share data between your Oracle Solaris 10 and Oracle Solaris 11 systems. As in Solaris 10 releases, data can be shared between your Oracle Solaris 10 and Oracle Solaris 11 systems by using the NFS protocol. In the Oracle Solaris 11 release, you can also share files between systems that are running Oracle Solaris and Windows by using the Server Message Block (SMB) protocol.
- **ZFS file system is the default file system** – ZFS fundamentally changes the way file systems are administered in Oracle Solaris. ZFS includes features and benefits that are not found in any other file system that is available today.

The following features help you transition either your UFS file system or your ZFS storage pools to systems that are running an Oracle Solaris 11 release:

- **Migrate your UFS data with ZFS shadow migration** – You can use the ZFS shadow migration feature to migrate your data from an existing file system to a new file system. You can either migrate a local file system to a new file system or migrate an NFS file system to a new local file system. See "Transitioning an Oracle Solaris 10 System to an Oracle Solaris 11 Release" on page 21.
- **Migrate your Oracle Solaris 10 storage pools** – You can export and disconnect storage devices that contain ZFS storage pools on your Oracle Solaris 10 systems and then import them into your Oracle Solaris 11 systems.
- **Other ways to migrate your UFS data** – You can remotely mount UFS file systems from an Oracle Solaris 10 system onto an Oracle Solaris 11 system. In addition, you can use the `ufsrestore` command to restore UFS data (`ufsdump`) into a ZFS file system.

See Chapter 4, "Managing Storage Features" and Chapter 5, "Managing File Systems".

Security Features

Security feature enhancements have been made in the following areas:

- Auditing
- Containment security
- Cryptographic security
- FIPS 140-2
- Network security
- Rights management
- System compliance

See Chapter 9, "Managing Security".

Virtualization Features

The following virtualization features are supported:

- OpenStack distribution (Juno version)
- Oracle Solaris Zones and Oracle Solaris Kernel Zones
- Oracle VM Server for SPARC

- Oracle VM Server for x86
- Oracle VM Templates
- Oracle VM VirtualBox

See Chapter 10, “Managing Virtualization Features”.

User Account Management and User Environment Features

User account management and user environment changes include the following:

- Administrative command locations
- Creating and managing user accounts
- Default user shell and path changes
- Development tools locations

See Chapter 11, “Managing User Accounts and User Environments”.

Observability, Debugging, and Tuning Features

Observability, debugging, and tuning feature changes include the following:

- **DTrace features** – DTrace feature changes include the following:
  - `errexit` **option** – An additional DTrace consumer option that specifies whether a DTrace script should exit upon encountering an error has been added. This enhancement changes the previous DTrace behavior, where an error is reported, but the script does not terminate.
  - `llquantize()` **action** – Support for a new linear-log quantize aggregating action has been added. This aggregating action enables you to collect data in linear-step buckets (similar to the existing `lquantize()` action) across multiple magnitudes simultaneously.
  - **Scalability improvements** – Internal processing for DTrace includes some scalability improvements that support better performance on larger systems.
  - **Structure and bitfield enhancements** – The expected behavior of user-defined structures and bitfields has been modified to adhere to the appropriate ABI specification for padding. This change might require you to remove any variables that were previously introduced as a workaround from your DTrace scripts.
  - `tracemem()` **enhancements** – This action includes an additional argument that specifies the number of bytes to display, which might be less than the number of bytes that was traced.

For additional information, see *Oracle Solaris 11.3 DTrace (Dynamic Tracing) Guide*.

- **Observing users and processes** – Use the `netstat` command with the `-u` option with to observe which users and processes are responsible for network connections. See `netstat`(1M) and "Displaying User and Process Information" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.
- **System tuning features** – The following system tuning feature enhancements have been made:
  - **NFS-related SMF configuration parameter changes** – The `network/nfs/server` service includes the `nfs-props` property group, which provides configurable parameters for controlling the refresh of the NFS authentication cache and the `mountd` netgroup cache. See Chapter 4, "NFS Tunable Parameters" in *Oracle Solaris 11.3 Tunable Parameters Reference Manual*.
  - **Oracle Solaris ZFS tunable parameters flash storage changes** – When using ZFS with Flash storage, refer to Chapter 3, "Oracle Solaris ZFS Tunable Parameters" in *Oracle Solaris 11.3 Tunable Parameters Reference Manual* for updated information pertaining to the following:
    - F20 PCIe Accelerator Card
    - F40 PCIe Accelerator Card
    - F80 PCIe Accelerator Card
    - F5100 Flash Storage Array
    - Flash SSDs

Desktop Features

The default desktop is the Oracle Solaris Desktop, which includes GNOME 2.30 from the GNOME Foundation, the Firefox Web browser, Thunderbird email client, and the Lightning calendar manager from the Mozilla Foundation.

Note - The login manager has changed from CDE to the GNOME Desktop Manager (GDM). If you are transitioning from Oracle Solaris 10 to an Oracle Solaris 11 release, and you previously customized your CDE login, review your display management configuration. You might need to make some changes to the GDM configuration to ensure it works as expected. See "Troubleshooting Desktop Transition Issues" on page 170.

See Chapter 12, "Managing the Oracle Solaris 11 Desktop".

♦ ♦ ♦ CHAPTER 2

Transitioning to an Oracle Solaris 11 Installation Method

Oracle Solaris 11 introduces new installation features and methods for system administrators. This chapter provides conceptual information and some brief examples to acquaint you with these new methods. For information about new installation features in this release, see "What's New in Installation for Oracle Solaris 11.3" in *Installing Oracle Solaris 11.3 Systems*.

For detailed instructions on installing Oracle Solaris 11.3, see *Installing Oracle Solaris 11.3 Systems*. For detailed instructions on installing another Oracle Solaris 11 release, see the relevant Oracle Solaris 11 installation documentation for that release.

For information about upgrading your system to Oracle Solaris 11.3, see *Updating to Oracle Solaris 11.3*.

For information about installing an Oracle Solaris virtual image on Oracle VM VirtualBox, see `https://www.oracle.com/technetwork/server-storage/solaris11/downloads/virtual-machines-1355605.html`.

The following topics are covered in this chapter:

Oracle Solaris Installation Features and Methods

The following table summarizes the installation features and methods that are available in this release. With the exception of the Automated Installer (AI) method, all of these installation

methods are used to install single systems. You can use AI to install single or multiple systems over the network.

TABLE 4 Supported Installation Methods

Installation Method	Preparation?	Install Server?	Single or Multiple Systems
Live Media GUI installation (**x86 only**)	Minimal	No	Single
Text installation	Minimal	No	Single
Text installation over the network	Yes	Yes, for retrieving the installation image from the server.	Single
Automated installations booting from media	Yes	Yes, for customized media preparation. No for installation.	Single
Automated installations of multiple clients	Yes	Yes	Single or multiple

Note - With the exception of the Live Media (x86 only) and the text installation methods, each of these installation methods installs software packages from an Oracle Solaris Image Packaging System (IPS) repository.

The following installation features are no longer supported:

- **Oracle Solaris Flash Archive Installation** – Use the Oracle Solaris Unified Archives feature. See "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129.
- **JumpStart feature of Oracle Solaris** – Use the AI feature. See *Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.3 Automated Installer*.

Oracle Solaris Installation Requirements

Before installing an Oracle Solaris 11 release, refer to the following requirements:

- **Memory** – The minimum memory requirement for installation is 1.5 GB. The Live Media ISO image and both the GUI and text installers are capable of functioning with a limited amount of memory. The exact requirement varies, depending on specific system specifications. See "System Requirements for Installing Oracle Solaris 11.3" in *Oracle Solaris 11.3 Release Notes* for more information.
- **Hardware** – Any supported SPARC or x86 platform. See `https://www.oracle.com/webfolder/technetwork/hcl/index.html`.

- **Virtual memory** – If you want to install an Oracle Solaris 11 virtual image on Oracle VM VirtualBox, refer to the memory requirements that are listed at `https://www.oracle.com/technetwork/server-storage/solaris11/downloads/virtual-machines-1355605.html`.

ZFS Root Pool Installation Requirements

Oracle Solaris 11 is installed in a ZFS storage pool called the *root pool*. The root pool installation requirements are as follows:

- **Disk space** – At least 13 GB of disk space is recommended. The space is consumed as follows:
  - **Swap area and dump device** – The default sizes of the swap and dump volumes that are created by the Oracle Solaris installation programs vary, based on the amount of memory that is on the system and other variables.

    After installation, you can adjust the sizes of your swap and dump volumes to sizes of your own choosing, as long as the new sizes support system operations. See "Managing ZFS Swap and Dump Devices" in *Managing ZFS File Systems in Oracle Solaris 11.3*.
  - **Boot environment (BE)** – A BE is approximately 6–8 GB in size, but can vary greatly depending on the size of the dump device. The size of the dump device is based on the size of the system's physical memory. In addition, consider that the size of a new BE increases when it is updated, depending on the amount of updates. You will need to monitor the disk space usage of all BEs on the system. All BEs in the same root pool use the same swap and dump devices.
  - **Oracle Solaris OS components** – All OS-related subdirectories of the root file system, for example, `/etc`, `/bin`, and `/usr`, cannot be created as a dataset that is separate from the root dataset. The only exception is `/var`, which the installers create as a separate dataset by default. In addition, all OS components must reside within the root pool, with the exception of the swap and dump devices. For information about specific disk requirements, see Chapter 3, "Managing Devices".
- **Support for running multiple operating systems (x86 only)** – You can partition the disk that will contain the OS prior to an installation or during an installation. See "Partitioning Your System" in *Installing Oracle Solaris 11.3 Systems*.

Oracle Solaris Preinstallation Tasks

Before installing an Oracle Solaris 11 release, review the following information:

- **x86: Prepare the boot environment (applies to x86 based systems that will run multiple operating systems)** – See "Preparing a System for Installing Multiple Operating Systems" in *Installing Oracle Solaris 11.3 Systems*.

- **Ensure that you have the proper device drivers** – Before installing Oracle Solaris, determine whether the devices on your system are supported. You can use the Device Driver Utility to ensure that your system has the proper devices. The Device Driver Utility can be accessed through the text installer menu options. See "Ensuring That You Have the Proper Device Drivers" in *Installing Oracle Solaris 11.3 Systems*. See also the Hardware Compatibility Lists (HCL) at `https://www.oracle.com/webfolder/technetwork/hcl/index.html`.
- **x86: Configure the system's date and time (applies to x86 platforms that are installed with AI only)** – Oracle Solaris keeps the Real Time Clock (RTC) in Coordinated Universal time (UTC) format. The behavior on x86 platforms is different than it was in Oracle Solaris 10. AI does not adjust the RTC date and time during an installation. To reconfigure the date and time after an installation, see "Reconfiguring Date and Time Before and After an Installation" on page 38.

Installing Oracle Solaris by Using Installation Media

You can install an Oracle Solaris 11 release by using any of the following installation methods:

- **x86: Live Media**

  The installer on the Live Media ISO image is for x86 platforms *only*. The Live Media installs a GUI desktop. Also, the Live Media requires more memory than the text installer. The exact memory requirements vary for each system. See "Oracle Solaris Installation Requirements" on page 30.

  If you are installing on x86 platforms that will run multiple operating systems, you can partition your disk during the installation process. See "Partitioning Your System" in *Installing Oracle Solaris 11.3 Systems*.

  The default GUI installer settings are described in "Default Settings With the GUI Installer" in *Installing Oracle Solaris 11.3 Systems*.

  To install the OS by using the Live Media or the text installer, download the installation media from `https://www.oracle.com/technetwork/server-storage/solaris11/downloads/index.html`

  You can copy the downloaded image to removable media, such as a USB drive or burn it to a DVD. USB images require the `usbcopy` utility to copy the bootable ISO image to a USB flash drive. In this release, USB installation media is also available for SPARC platforms. To use the `usbcopy` utility, first install the `pkg:/install/distribution-constructor` package. For instructions on creating a persistent device alias for a USB stick on a SPARC based system, see "How to Create a Persistent Device Alias for a USB Flash Drive on a SPARC System" in *Installing Oracle Solaris 11.3 Systems*.
- **Interactive text installer**

The text installation media contains a set of software that is more appropriate for a general-purpose server. The text installer can perform an installation on an existing Oracle Solaris x86 partition or on a SPARC slice. Or, the text installer can use the entire disk. If the whole disk option is selected, a partition or slice is created to cover the targeted device. In either case, the installation overwrites everything on the targeted partition or slice. See "How to Perform a Text Installation" in *Installing Oracle Solaris 11.3 Systems*. If you use the text installer, you might need to install additional software packages afterwards. See "Adding Software After a Text Installation" in *Installing Oracle Solaris 11.3 Systems*.

Note - The text installer installs the `solaris-large-server` package set. However, if you use the text installer over the network, the `solaris-autoinstall` package set is installed. After booting the installed system, you should install the `solaris-large-server` package set.

If you are set up to perform an automated installation over the network, you can also perform an interactive text installation over the network. When using this method, you can only install a single system at a time. However, you can modify installation specifications by using the interactive selections. See "How to Start a Text Installation Over the Network" in *Installing Oracle Solaris 11.3 Systems*.

- **Automated installations that boot from media**

  You can boot an AI image from media or a USB device to initiate a hands-free installation of just that system. An AI manifest provides installation instructions for the system. You can use the interactive AI manifest wizard to simplify AI manifest creation. See "Creating an AI Manifest Using the AI Manifest Wizard" in *Installing Oracle Solaris 11.3 Systems*. The system must have the minimum amount of required memory and adequate disk space. Also, the system must have network access so that software packages can be retrieved from an IPS repository on the Internet or on the local network. This step is required to complete the installation. See "Installing Using AI Media" in *Installing Oracle Solaris 11.3 Systems*.

You can also create custom Live Media images, text installer images, and AI images. See *Creating a Custom Oracle Solaris 11.3 Installation Image*.

Note - After installing your system, you cannot update it by using a method that is similar to any Oracle Solaris 10 upgrade methods. An Oracle Solaris system is updated based on your desired maintenance schedule and by using the `pkg` command. See *Adding and Updating Software in Oracle Solaris 11.3* and *Updating to Oracle Solaris 11.3* for more details.

Before updating to Oracle Solaris 11.3, see "Issues When Updating to Oracle Solaris 11.3" in *Oracle Solaris 11.3 Release Notes*.

The media paths for the Oracle Solaris 11.3 installers are as follows:

- **x86 only: Live Media** – `sol-11_3-live-x86.iso`, `sol-11_3-live-x86.usb`
- **SPARC: Interactive text installer** – `sol-11_3-text-sparc.iso`, `sol-11_3-text-sparc.usb`
- **x86: Interactive text installer** – `sol-11_3-ai-x86.iso`, `sol-11_3-ai-x86.usb`
- **SPARC: Automated Installer** – `sol-11_3-ai-sparc.is`, `sol-11_3-ai-sparc.usb`
- **x86: Automated Installer** – `sol-11_3-text-x86.iso`, `sol-11_3-text-x86.usb`

Note - Media paths might vary if you are downloading from a location other than the Oracle Technical Network, for example, from My Oracle Support or the Oracle Software Delivery Cloud.

Transitioning From JumpStart to AI

AI performs automated (or hands-free) installations of networked systems. This installation method replaces the JumpStart installation method that is used in Oracle Solaris 10. The `js2ai` utility is available as a migration tool to assist you in moving from a JumpStart installation method to AI. You can use the `js2ai` utility to perform several migration tasks. To use the utility, you must first install the appropriate software package: See *Transitioning From Oracle Solaris 10 JumpStart to Oracle Solaris 11.3 Automated Installer* and the `js2ai`(1M) man page.

Installing Oracle Solaris by Using AI

You can use the AI installation method to perform a hands-free installation of Oracle Solaris on single or multiple systems. This installation method requires an install server setup. See Part 3, “Installing Using an Install Server,” in *Installing Oracle Solaris 11.3 Systems*. Also, each system that is to be installed must have network access to retrieve necessary packages during the installation process from a networked IPS repository.

Keep the following key points in mind when using AI:

- You can use AI to install single or multiple clients over the network.
- An AI server provides multi-platform installation support. However, you must create a separate install service for each client architecture (SPARC and x86), as well as each Oracle Solaris OS version that you plan to install.
- Clients must be able to access an IPS software package repository to retrieve the required software packages for the installation.

- The location of the IPS package repository, which is specified by a Universal Resource Identifier (URI), can be on the install server, on a server that is on the local network, or on the Internet. See "Configuring Publishers" in *Adding and Updating Software in Oracle Solaris 11.3*.
- You can optionally customize installation clients with specific installation parameters, for example, disk layout and software selection.
- You can optionally customize clients with specific system configuration parameters, for example, host name, network configuration, and user account information.
- You can make customizations on a client-by-client basis, as well as scale customizations for large enterprise environments.

For additional information about the AI process and new AI features, see Part 3, "Installing Using an Install Server," in *Installing Oracle Solaris 11.3 Systems*.

AI Preinstallation Tasks

Prior to installing a system with AI, you must perform certain tasks. At minimum, you must set up an AI install server and create at least one install service. This scenario works well in situations where all of the clients are of the same architecture and will be installed with the same version of Oracle Solaris. This type of installation uses the default AI manifest, which is not associated with any client criteria. When you create a new AI install service, */install-service-image-path*`/auto_install/manifest/default.xml`, is the initial default AI manifest for that install service. The default AI manifest specifies the most recent version of the Oracle Solaris 11 release that is available from the IPS package repository (`http://pkg.oracle.com/solaris/release`).

For the client machine that is to be installed, AI uses DHCP to provide the IP address, subnet mask, router, name service server, and the location of the install server. SPARC clients can optionally get their network configuration and install server location from the `network-boot-arguments` variable that is set in the OpenBoot PROM (OBP). Note that the DHCP server and AI install server can be the same system or on two different systems. For more information about setting up an AI install server, see Chapter 8, "Setting Up an AI Server" in *Installing Oracle Solaris 11.3 Systems*.

For additional information about customizing AI installations, provisioning client systems, and configuring client systems, refer to the following documentation:

- Chapter 9, "Assigning Customizations to AI Clients" in *Installing Oracle Solaris 11.3 Systems*
- Chapter 10, "Defining AI Client Installation Parameters" in *Installing Oracle Solaris 11.3 Systems*
- Chapter 11, "Defining AI Client System Configuration Parameters" in *Installing Oracle Solaris 11.3 Systems*

Setting Up an Install Client

When you initially set up your install server, you must create at least one install service for each client architecture and for each version of Oracle Solaris that you plan to install. For each install service that you create for the different client architectures, you must also create customized installation instructions and system configuration instructions. Each client is then directed to the AI install server to access the information for the correct install service, as well as the AI manifest and the system configuration profiles within that install service. If you do not provide adequate system configuration instructions prior to the installation, an interactive tool opens during the first boot after the installation, prompting you for any missing system configuration information.

Setting up an install client requires you to run the `installadm create-client` command on the install server, which associates a particular client with a particular install service. For example, you would set up a SPARC install client and associate the client with the MAC address `00:14:4f:a7:65:70` and the `solaris11_2-sparc` install service as follows:

```
# installadm create-client -n solaris11_2-sparc -e 00:14:4f:a7:65:70
```

In this particular example, the DHCP server does not require configuration because the SPARC `wanboot-cgi` boot file has already been configured by using the `create-service` command. See "Creating an Install Service" in *Installing Oracle Solaris 11.3 Systems*.

For information about setting up an x86 install client, see "Setting Up an x86 AI Client" in *Installing Oracle Solaris 11.3 Systems*.

Booting the Client and Initiating an Oracle Solaris Installation

After performing the required prerequisite tasks for using AI, plus any optional customization tasks, you are ready to install the client system. The installation begins when you boot the client system over the network.

Boot a SPARC client as follows:

1. Bring the system to the `ok` OBP prompt, then boot the system.

   ```
   ok boot net:dhcp - install
   ```

   Note - The syntax for booting a SPARC based system from the network has changed in Oracle Solaris 11.

If you are *not* using DHCP, use this command:

```
ok setenv network-boot-arguments host-ip=client-ip,
router-ip=router-ip,subnet-mask=subnet-mask,hostname=hostname,
file=wanboot-cgi-file
```

When you use the `network-boot-arguments` variable, the SPARC client does *not* have DNS configuration information. Ensure that the AI manifest that is used with the client specifies an IP address instead of a host name for the location of the IPS package repository, and for any other URI in the manifest.

2. Boot the system.

```
ok boot net - install
```

See "Installing a SPARC AI Client" in *Installing Oracle Solaris 11.3 Systems* for a list of the events that occur during a SPARC client installation.

Perform a PXE boot of an x86 client as follows:

1. Boot the client system.
2. When the client boots, instruct the firmware to boot from the network by typing the specific key sequence when the firmware (BIOS or UEFI) screen is displayed.

   For information about UEFI firmware support on x86 platforms, see"Booting Systems With UEFI and BIOS Firmware From the Network" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.
3. When the GRUB menu is displayed, select the second entry (Automated Install), then press Return to install that image.

```
Oracle Solaris 11.3 Text Installer and command line
Oracle Solaris 11.3 Automated Install
```

   See "Installing an x86 AI Client" in *Installing Oracle Solaris 11.3 Systems* for a list of the events that occur during an x86 client installation.

   For examples of a different types of installation scenarios, see "Automated Installer Use Cases" in *Installing Oracle Solaris 11.3 Systems*.

Installing and Configuring Zones During the AI Process

Non-global zones are installed and configured on the first reboot after the global zone is installed. With AI, you can install non-global zones on the system by using the configuration

element that is defined in the AI manifest. During the first boot after the global zone installation, the zone's self-assembly SMF service (`svc:/system/zones-install:default`) configures and installs each non-global zone that is defined in the global zone AI manifest. If the zone is configured with the `auto-boot` property set to `true` (`autoboot=true`), the `system/zones-install` service boots the zone after installing it. See Chapter 12, "Installing and Configuring Zones" in *Installing Oracle Solaris 11.3 Systems*.

Download Locations for AI Files

During an AI installation, several important AI files are downloaded to the following locations:

- **Installation log file** – `/system/volatile/install_log`
- **AI client manifest that is downloaded from the AI server** – `/system/volatile/ai.xml`
- **AI client derived manifest (if used)** – `/system/volatile/manifest.xml`
- **SC profiles that are downloaded from the AI server** – `/system/volatile/profile/*`
- **List of AI services** – `/system/volatile/service_list`

Additional Installation Tasks

You might need to perform the following additional tasks before or after an installation.

Reconfiguring Date and Time Before and After an Installation

Oracle Solaris 11 keeps the Real Time Clock (RTC) in Coordinated Universal time (UTC) format. The behavior on x86 platforms is different in this release than in Oracle Solaris 10. The interactive installers enable you to configure the date and time during the installation. As part of that process, the RTC is updated with the time in UTC format. However, AI does *not* adjust the RTC date and time during an installation. To ensure that the time stamp of installed files is correct, configure the time in the BIOS in UTC format *before* beginning the installation. On x86 platforms, when using the `pkg update` command, the OS continues to keep time in RTC in the local time format. This method is used to avoid time inconsistencies between Oracle Solaris 11 BEs and BEs from previous releases.

Note - If you are running Oracle Solaris 11 as an Oracle VM VirtualBox guest, check or uncheck the Hardware Clock in UTC time setting in the system preferences for the virtual machine.

Switching From Local Time Format to UTC Format

To switch from local time format to UTC format, set the time lag between the kernel and RTC to 0 (zero) as follows:

```
# rtc -z GMT
```

If the date/time requires an adjustment, use the `date` command. See `date(1)`.

Switching From UTC Format to Local Time Format

When the switch from UTC to local time is complete, and each time you reconfigure the time zone setting by using the `sysconfig` command, run the `rtc` *timezone* command with the `-z` option as follows:

```
# rtc -z timezone
```

Maintaining Local Time on a System Running Multiple Operating Systems That Keep RTC Time as Local Time

If you maintain and boot several operating systems on the same Oracle Solaris 11 system, and those operating systems keep RTC time as local time, there are several ways that these operating systems can coexist, from the RTC time point of view:

- Switch from local time to UTC format in the OS that keeps RTC time in local time format.

  For example, if you are dual-booting Windows 7, set the registry key as follows:

  ```
  [HKEY_LOCAL_MACHINESYSTEM\CurrentControlSet\Control\TimeZoneInformation] \
  "RealTimeIsUniversal"=dword:00000001
  ```
- Switch from the UTC format to local time on a freshly installed Oracle Solaris 11 system.
- Enable the Network Time Protocol (NTP) in operating systems that assume that the RTC format is running in local time. In this case, the time is synchronized automatically.

Monitoring the Live Media Startup Process

Switching to the text boot screen is useful if you suspect that the system startup process is not proceeding normally. The text screen might contain informational messages or a request for user input. Switching to the text boot screen has no impact on the boot sequence, other than

how the information is displayed on the screen. Initialization of the operating system continues and completes as normal.

To switch to a text boot, press any key a few seconds after the GUI boot screen appears and the progress animation begins. Note that after switching from the GUI boot to a text boot, you cannot switch back to the GUI boot screen.

x86: Adding Custom Entries to the GRUB Menu After an Installation

Starting with Oracle Solaris 11.1, GRUB 2 is the default boot loader on x86 platforms. GRUB 2 uses a different configuration file (`grub.cfg`) than the `menu.lst` file that is used by GRUB Legacy. The `grub.cfg` file contains most of the GRUB configuration, including all Oracle Solaris menu entries. Unlike the `menu.lst` file, you manage the `grub.cfg` file *solely* by using the `bootadm` command. Do *not* directly edit this file.

Also, the `grub.cfg` file does not contain any custom menu entries. For custom menu entries, there is an additional configuration file (`custom.cfg`) that you can use. Before adding custom menu entries to the `custom.cfg` first, you first have to create the file and then store it in the same location as the `grub.cfg` and `menu.conf` files (*/pool-name*`/boot/grub/`) are stored.

During the boot process, GRUB checks for the existence of a `custom.cfg` file in the toplevel dataset of the root pool, in the `boot/grub` subdirectory. If the file exists, GRUB sources the file and then processes any commands within the file as though the contents were textually inserted in the main `grub.cfg` file.

For example, on a system with 64-bit UEFI firmware, `custom.cfg` file entries might appear as follows:

```
menuentry "Windows (64-bit UEFI)" {
insmod part_gpt
insmod fat
insmod search_fs_uuid
insmod chain
search --fs-uuid --no-floppy --set=root cafe-f4ee
chainloader /efi/Microsoft/Boot/bootmgfw.efi
}
```

On a system with BIOS firmware, entries in this file might appear as follows:

```
menuentry "Windows" {
insmod chain
set root=(hd0,msdos1)
```

```
chainloader --force +1
}
```

See "Customizing the GRUB Configuration" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

Additional Installation Troubleshooting Information

Refer to the following additional troubleshooting information for issues that you might encounter during or after installing Oracle Solaris 11:

- Before installing Oracle Solaris, review "Installation Considerations" in *Oracle Solaris 11.3 Release Notes*.
- For information about troubleshooting issues that you might encounter during an installation, see "Issues When Installing Oracle Solaris 11.3" in *Oracle Solaris 11.3 Release Notes*.
- For information about troubleshooting issues that you might encounter when upgrading to Oracle Solaris 11.3, see "Issues When Updating to Oracle Solaris 11.3" in *Oracle Solaris 11.3 Release Notes*.
- For information about troubleshooting issues with booting a system after an installation, see "What to Do If Your System Boots in Console Mode" in *Installing Oracle Solaris 11.3 Systems*.

♦ ♦ ♦ CHAPTER 3

Managing Devices

This chapter provides information about managing devices in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Managing Devices With the Oracle Hardware Management Pack

Oracle Solaris 11 includes the Oracle Hardware Management Pack. In previous releases, this package was available as a separate download only. Installed features are among those that are included in the `system/management` software package. For more details go to `https://www.oracle.com/technetwork/documentation/sys-mgmt-networking-190072.html#hwmgmt`.

Device and Driver Management Changes

Device and driver identity and configuration has changed as follows:

- As in Oracle Solaris 10 releases, all supported devices that are connected to the system when it is installed should be accessible after installation. You can configure devices by using the `cfgadm` command and most devices are hot-pluggable, which means you can add and remove devices while the system is booted.
- The `hotplug` command provides offline and online capabilities, as well as enable and disable operations for PCI Express (PCIe) and PCI SHPC (Standard Hot Plug Controller) devices. Note that you can still use the `cfgadm` command to manage hot pluggable USB and

SCSI devices. See Chapter 2, “Dynamically Configuring Devices” in *Managing Devices in Oracle Solaris 11.3*.

- You can more easily identify physical device location information by using the `croinfo` command.

  Use the following commands to display information by chassis, receptacle, and occupant values for the devices on your system:

  - `diskinfo` – Displays general information about physical disk locations.
  - `format` – Displays physical disk location information for disks when reviewing partition tables or relabeling.

    For example, the following `format` output identifies the two internal disks on this system, under `/dev/chassis/SYS/HDO` and `/dev/chassis/SYS/HD1`:

    ```
    # format
    Searching for disks...done

    AVAILABLE DISK SELECTIONS:
    0. c1t0d0 <FUJITSU-MAY2073RCSUN72G-0401 cyl 8921 alt 2 hd 255 sec 63>
    /pci@0,0/pci1022,7450@2/pci1000,3060@3/sd@0,0
    /dev/chassis/SYS/HD0/disk
    1. c1t1d0 <FUJITSU-MAY2073RCSUN72G-0401-68.37GB>
    /pci@0,0/pci1022,7450@2/pci1000,3060@3/sd@1,0
    /dev/chassis/SYS/HD1/disk
    ```

    The previous output identifies two internal system disks, but disks from a storage array are generally identified by their storage array name.
  - `prtconf -l` – Displays system configuration information that includes physical disk location information.
  - `zpool status -l` – Displays physical disk location information for pool devices.

    In addition, you can use the `fmadm add-alias` command to include a disk alias name that helps you identify the physical location of disks in your environment, as shown in the following example:

    ```
    # fmadm add-alias SUN-Storage-J4200.0912QAJ001 J4200@RACK10:U26-27
    # fmadm add-alias SUN-Storage-J4200.0905QAJ00E J4200@RACK10:U24-25
    ```

- Use the `diskinfo` command as follows to determine where a disk is located:

  ```
  % diskinfo -c c0t24d0
  D:devchassis-path                                  t:occupant-type  c:occupant-
  compdev
  -------------------------------------------------  --------------
   ------------------
  ```

```
/dev/chassis/J4200@RACK10:U26-27/SCSI_Device__9/disk  disk            c0t24d0
```

In the previous example, the `/dev/chassis` disk name includes an alias name that helps you locate the device in your environment.

The following example shows how to display a specific disk's physical location:

```
$ diskinfo -c c0t24d0 -o cp
c:occupant-compdev  p:occupant-paths
------------------  ----------------------------------------------------------
c0t24d0             /devices/pci@0,600000/pci@0/pci@9/LSILogic,sas@0/sd@18,0
```

Note - The `diskinfo` command requires that chassis support SES diagnostic page 0xa (Additional Element Status) and must set the Element Index Present (EIP) bit to 1. Enclosures that do not meet this criteria will not be fully enumerated, and thus, will not be properly represented.

- Driver customizations are made in the `/etc/driver/drv` directory rather than in the `/kernel directory` as in previous releases. This improvement means that your driver customizations are not overwritten when the system is upgraded. The files in the `/etc/driver/drv` directory are preserved during the upgrade. Customizing a driver configuration usually means that a per-device parameter or global property that impacts all devices is added or modified. See "How to Customize a Driver Configuration" in *Managing Devices in Oracle Solaris 11.3*.

Preparing Disks for ZFS Storage Pools

Creating ZFS storage pools in Oracle Solaris 11 is similar to creating pools in Oracle Solaris 10. The following sections provide summary information about preparing disks for a ZFS root pool and non-root pools.

Review the following general pool device configuration recommendations:

- Create non-root pools by using whole disks, which are easier to manage than disk slices. For example, you can easily create a mirrored storage pool with four devices as follows:

```
# zpool create tank mirror c0t1d0 c0t2d0 mirror c1t1d0 c1t2d0
```

- When ZFS storage pools are created with whole disks, the disks are labeled with an EFI label rather than an SMI label. You can identify an EFI label by the lack of cylinder information in the disk label as displayed in the format utility, as shown in the following example:

```
partition> print
Current partition table (original):
Total disk sectors available: 286478269 + 16384 (reserved sectors)

Part      Tag    Flag     First Sector         Size         Last Sector
0        usr    wm               256      136.60GB          286478302
1 unassigned    wm                 0           0               0
2 unassigned    wm                 0           0               0
3 unassigned    wm                 0           0               0
4 unassigned    wm                 0           0               0
5 unassigned    wm                 0           0               0
6 unassigned    wm                 0           0               0
8   reserved    wm         286478303        8.00MB          286494686
```

- Whenever possible, create non-root pools with whole disks.

Oracle Solaris releases support advanced format disks in addition to traditional 512n disks. See "Using Advanced Format Disks" in *Managing Devices in Oracle Solaris 11.3*.

ZFS Root Pool Installation Improvements

Review the following installation improvements for root pools:

- **Disk labeling changes** – If the disk label or labels that are intended to contain the OS are unknown, the disks are automatically relabeled with the appropriate disk label.

  SPARC based systems with GPT-aware firmware and most x86 based systems are installed with an EFI (GPT) label on the root pool disk or disks. See "SPARC: GPT Labeled Disk Support" in *Oracle Solaris 11.3 Release Notes* for further instructions.

  In addition, the AI installer has improved the `whole_disk` keyword syntax so that if `whole_disk` is set to `true`, the disk's contents are replaced, even if it has existing partitions or slices.
- **AI installation of a mirrored root pool** – Oracle Solaris 10 installation features enable you to create a mirrored root pool during installation. You can use AI manifest keyword syntax to create a mirrored root pool during an Oracle Solaris 11 automated installation. For example, the following syntax creates a mirrored root pool that uses whole disks:

  ```
  <!DOCTYPE auto_install SYSTEM "file:///usr/share/install/ai.dtd.1">
  .
  .
  .
  <target>
  <disk whole_disk="true" in_zpool="rpool" in_vdev="mirrored">
  ```

```
<disk_name name="c1t0d0" name_type="ctd"/>
</disk>
<disk whole_disk="true" in_zpool="rpool" in_vdev="mirrored">
<disk_name name="c2t0d0" name_type="ctd"/>
</disk>
<logical>
<zpool name="rpool" is_root="true">
<vdev name="mirrored" redundancy="mirror"/>
<!--
Subsequent <filesystem> entries instruct an installer to create
following ZFS datasets:

<root_pool>/export         (mounted on /export)
<root_pool>/export/home    (mounted on /export/home)
.
.
.       </zpool>
</logical>
</target>
.
.
.
```

ZFS Root Pool Device Requirements

In general, root pool devices are relabeled and the root pool is created when the system is installed.

Review the following additional information about ZFS root pool devices:

- In Oracle Solaris 11, an SMI (VTOC) label is applied automatically to the root pool disk or disks during an installation on both SPARC and x86 based systems, as shown in the following example:

```
# zpool status rpool
pool: rpool
state: ONLINE
scan: none requested
config:

NAME        STATE     READ WRITE CKSUM
rpool       ONLINE       0     0     0
c7t0d0s0  ONLINE       0     0     0
```

- Starting with Oracle Solaris 11.2, an EFI label is applied automatically to the root pool disk or disks during installation on SPARC based systems with GPT-enabled firmware (See "Firmware, Disk Labeling, and EEPROM Changes" on page 122) and most x86 based systems. Otherwise, a VTOC disk label is installed on the root pool disk, as shown in the following example:

```
# zpool status rpool
pool: rpool
state: ONLINE
scan: none requested
config:

NAME      STATE     READ WRITE CKSUM
rpool     ONLINE       0     0     0
c7t0d0  ONLINE       0     0     0
```

  When you attach a disk to create a mirrored root pool, use the whole disk syntax as follows:

```
# zpool attach rpool c7t0d0 c7t2d0
Make sure to wait until resilver is done before rebooting.
```

  The pool remains in a `DEGRADED` state until the new disk is resilvered, as shown in the following example:

```
# zpool status rpool
pool: rpool
state: DEGRADED
status: One or more devices is currently being resilvered.  The pool will
continue to function in a degraded state.
action: Wait for the resilver to complete.
Run 'zpool status -v' to see device specific details.
scan: resilver in progress since Thu Jan 24 08:15:13 2013
224M scanned out of 22.0G at 6.59M/s, 0h56m to go
221M resilvered, 0.99% done
config:

NAME        STATE     READ WRITE CKSUM
rpool       DEGRADED     0     0     0
mirror-0  DEGRADED     0     0     0
c7t0d0  ONLINE       0     0     0
c7t2d0  DEGRADED     0     0     0  (resilvering)
```

- The pool must exist either on a disk slice or on disk slices that are mirrored. If you attempt to use an unsupported pool configuration during a `beadm` operation, a message similar to the following is displayed:

```
ERROR: ZFS pool name does not support boot environments
```

- On an x86 based system, the disk must contain an Oracle Solaris `fdisk` partition. An Oracle Solaris `fdisk` partition is created automatically when an x86 based system is installed. See "Using the fdisk Option" in *Managing Devices in Oracle Solaris 11.2*.

For more information about managing ZFS root pools, see Chapter 6, "Managing the ZFS Root Pool" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

ZFS Root Pool Disk and Boot Administration

The following ZFS root pool disk and boot administration summary pertains to systems running at least Oracle Solaris 11.1. If you are running Oracle Solaris 11 11/11, refer to the ZFS product documentation for information that pertains specifically to that release.

- **SPARC:** OBP requires a root pool disk with an SMI (VTOC) label.
- **SPARC:** If replacing a root pool disk with the `zpool replace` command, apply boot blocks manually as follows:

```
# bootadm install-bootloader
```

- **SPARC:** Attaching a root pool disk with the `zpool attach` command to create a mirrored root pool requires the following the slice syntax:

```
# zpool attach rpool c0t5000CCA03C5A5314d0s0 c0t5000CCA03C5A5340d0s0
```

- **x86:** GRUB 2 and the root pool disk has an EFI label in most cases.
- **x86:** If replacing a root pool disk with the `zpool replace` command, apply the boot blocks manually as follows:

```
# bootadm install-bootloader
```

- **x86:** Attaching a root pool disk with the `zpool attach` command to create a mirrored root pool requires the whole disk syntax, as shown in the following example:

```
# zpool attach rpool c0t5000CCA03C5A5314d0 c0t5000CCA03C5A5340d0
```

Swap and Dump Device Configuration Changes

Swap space is a reserved area of a disk that the Oracle Solaris OS software and application software can use for temporary storage. Swap space is used as virtual memory storage areas when the system does not have enough physical memory to handle current processes that are running. In Oracle Solaris 10 a UFS root environment provides one disk slice for both swap

and dump devices. In Oracle Solaris 11, two separate volumes are created as a swap device and a dump device. In a ZFS root file system, the disk space that is reserved for swap is a ZFS volume. Use the `dumpadm` command as follows to display this information:

```
# dumpadm
Dump content: kernel pages
Dump device: /dev/zvol/dsk/rpool/dump (dedicated)
Savecore directory: /var/crash
Savecore enabled: yes
Save compressed: on

# swap -l
swapfile             dev    swaplo   blocks     free
/dev/zvol/dsk/rpool/swap 182,2         8  4061176  4061176
```

Display information about the swap and dump volume names and sizes as follows:

```
# zfs list -t volume -r rpool
NAME         USED  AVAIL  REFER  MOUNTPOINT
rpool/dump  4.13G  51.6G  4.00G  -
rpool/swap  4.13G  51.6G  4.00G  -
```

You can display swap space sizes in human-readable format, as shown in the following example:

```
# swap -sh
total: 1.4G allocated + 227M reserved = 1.6G used, 432G available
# swap -lh
swapfile                   dev    swaplo   blocks     free
/dev/zvol/dsk/rpool/swap 285,2        8K     4.0G     4.0G
```

Managing ZFS swap and dump volumes differs from how you manage a single slice for a UFS swap and dump device in the following ways:

- You cannot use a single volume for both swap and dump devices in a ZFS root environment.
- You cannot use a file as a swap device in a ZFS root environment.
- The system requires that the dump device is approximately 1/2 to 3/4 the size of physical memory. If the dump device is too small, an error similar to the following is displayed:

  ```
  # dumpadm -d /dev/zvol/dsk/rpool/dump
  dumpadm: dump device /dev/zvol/dsk/rpool/dump is too small to hold a system dump
  dump size 36255432704 bytes, device size 34359738368 bytes
  ```

You can easily increase the size of the dump device by increasing the volume's `volsize` property, as shown in the following example. Note that it might take some time to reinitialize the volume.

```
# zfs get volsize rpool/dump
```

```
NAME        PROPERTY  VALUE  SOURCE
rpool/dump  volsize   1.94G  local
# zfs set volsize=3g rpool/dump
# zfs get volsize rpool/dump
NAME        PROPERTY  VALUE  SOURCE
rpool/dump  volsize   3G     local
```

Changing the size of the swap volume is difficult if the swap device is in use. Consider creating a second swap volume and adding it as a swap device as follows:

```
# zfs create -V 3G rpool/swap2
# swap -a /dev/zvol/dsk/rpool/swap2
# swap -l
swapfile             dev    swaplo   blocks     free
/dev/zvol/dsk/rpool/swap 182,2         8  4061176  4061176
/dev/zvol/dsk/rpool/swap2 182,4         8  6291448  6291448
```

Then, add an entry for the new swap device in the `/etc/vfstab` file as follows:

```
/dev/zvol/dsk/rpool/swap2    -        -       swap    -       no      -
```

For information about managing system crashes by using the *deferred dump* process, see "System Configuration Changes" on page 109. For information about file systems, see *Managing File Systems in Oracle Solaris 11.3*.

♦ ♦ ♦ CHAPTER 4

Managing Storage Features

This chapter describes storage management changes in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Comparing Solaris Volume Manager Configurations to ZFS Configurations

In Oracle Solaris 10, you can create redundant volumes for UFS file systems by using Solaris Volume Manager. Solaris Volume Manager is a traditional volume management product with a layer of volume management and a layer of file system management.

ZFS, available in Oracle Solaris 10 and Oracle Solaris 11 releases, eliminates volume management altogether. Instead of creating virtualized volumes, ZFS aggregates devices into a storage pool. The storage pool describes the physical characteristics of the storage (device layout, data redundancy, and so on) and acts as an arbitrary data store from which file systems can be created. File systems are no longer constrained to individual devices, which enables them to share disk space with all of the file systems in the pool.

In Oracle Solaris 11, you can create a redundant ZFS storage pool in one command. ZFS provides two types of redundant configurations: mirrored pools and RAID-Z pools. RAID-Z configurations are similar to RAID-5 configurations.

ZFS dynamically stripes data across all non-redundant, mirrored, and RAID-Z configurations. Note the following additional information:

- Solaris Volume Manager RAID-0 (stripe and concatenation) is not available in ZFS RAID-Z configurations.

- Solaris Volume Manager RAID-1 (mirror) is available as a ZFS mirrored configuration, as shown in the following example:

```
# zpool create tank mirror c1t0d0 c2t0d0 mirror c1t1d0 c2t1d0
```

- Solaris Volume Manager RAID-5 (distributed parity) is available as a ZFS RAID-Z (`raidz1`) configuration, as shown in the following example:

```
# zpool create rzpool raidz1 c1t0d0 c2t0d0 c1t1d0 c2t1d0
```

- Solaris Volume Manager does not offer a RAID-6 but ZFS provides both RAIDZ-2 and RAIDZ-3 parity configurations, which means a RAIDZ-2 configuration can withstand the failure of two disks. A RAIDZ-3 configuration can withstand the failure of 3 disks, as shown in the following example:

```
# zpool create rzpool raidz2 c0t1d0 c1t1d0 c4t1d0 c5t1d0 c6t1d0 c7t1d0
raidz2 c0t2d0 c1t2d0 c4t2d0 c5t2d0 c6t2d0 c7t2d0
```

ZFS Storage Pool Best Practices

ZFS uses a pool storage model where storage devices are aggregated into a storage pool. File systems within the storage pool use all of the storage in the pool.

ZFS Storage Pool Creation Best Practices

- **Specific root pool device and boot disk requirements**

  See these references:

  - “ZFS Root Pool Device Requirements” on page 47
  - “ZFS Root Pool Disk and Boot Administration” on page 49
- **General root pool creation best practices**
  - You must create the root pool as a mirrored configuration or as a single-disk configuration. Neither a RAID-Z nor a striped configuration is supported. You cannot add additional disks to create multiple mirrored top-level virtual devices by using the `zpool add` command. To expand a mirrored virtual device, use the `zpool attach` command.
  - The root pool cannot have a separate log device.
  - You can set pool properties during an installation with AI by using the `pool_options` keyword syntax, but the `gzip` compression algorithm is not supported on root pools.
  - Do not rename the root pool after it is created by an initial installation. Renaming the root pool might result in an unbootable system.

- Do not create a root pool on a USB stick for a production system because root pool disks are critical for continuous operation, particularly in an enterprise environment. Consider using a system's internal disks for the root pool, or at minimum, use the same quality disks that you would use for your non-root data. In addition, a USB stick might not be large enough to support a dump volume size that is equivalent to at least 1/2 the size of physical memory.
- Consider keeping root pool components separate from non-root pool data.

- **Non-root pool creation best practices**

  Create non-root pools with whole disks by using the `d*` identifier. Do not use the `p*` identifier.

  - ZFS works best without any additional volume management software.
  - For better performance, use individual disks or at least logical unit numbers (LUNs) that are made up of just a few disks. By providing ZFS with more visibility into the LUN setup, ZFS is able to make better I/O scheduling decisions.
  - **Mirrored storage pools** – Consume more disk space but generally perform better with small random reads, as shown in the following example:

    ```
    # zpool create tank mirror c1d0 c2d0 mirror c3d0 c4d0
    ```

    Mirrored storage pools are also more flexible, in that you can detach, attach, and replace existing devices in the pool.
  - **RAID-Z storage pools**

    You can create RAID-Z storage pools with 3 parity strategies, where parity equals 1 (`raidz`), 2 (`raidz2`), or 3 (`raidz3`).

    - A RAID-Z configuration maximizes disk space and generally performs well when data is written and read in large chunks (128K or more). Create a single-parity RAIDZ (`raidz`) configuration at 3 disks (2+1).
    - A RAIDZ-2 configuration offers better data availability, and performs similarly to RAID-Z. RAIDZ-2 has significantly better mean time to data loss (MTTDL) than either RAID-Z or 2-way mirrors. Create a double-parity RAID-Z (`raidz2`) configuration at 6 disks (4+2).
    - A RAIDZ-3 configuration maximizes disk space and offers excellent availability because it can withstand 3 disk failures. Create a triple-parity RAID-Z (raidz3) configuration at 8 disks (5+3).

- **Non-redundant pools**

  If you create a non-redundant pool, you will see a message similar to the following:

  ```
  # zpool create pond c8t2d0 c8t3d0
  'pond' successfully created, but with no redundancy; failure of one
  device will cause loss of the pool
  ```

Creating a pool with no redundancy is not recommended because a device failure could mean that the data is unrecoverable. Consider creating a ZFS storage pool with redundancy as follows:

```
# zpool create pond mirror c8t2d0 c8t3d0
```

ZFS Storage Pool Monitoring Best Practices

Refer to the following best practices for monitoring ZFS storage pools:

- Make sure that pool usage is below 90% of pool capacity for best performance.

  Note that the `zpool list` command does not count RAID-Z parity as used space, nor does it subtract it from the pool capacity. RAID-Z pool capacity might be below 90%, while being nearly full. Use the `zfs list` *pool* command to check. See "Displaying ZFS File System Information" on page 62.
- Use the `zpool scrub` command on a regular basis to identify data integrity problems:
  - If you have consumer quality drives, consider a weekly scrubbing schedule.
  - If you have datacenter quality drives, consider a monthly scrubbing schedule.
  - You should also run a scrub prior to replacing devices to ensure that all devices are currently operational.
- Use the `zpool status` command on a weekly basis to monitor pool and pool device status. Also use the `fmdump` or `fmdump -ev` command to determine if any device faults or errors have occurred.

Troubleshooting ZFS Storage Pool Issues

Review the following new diagnostic descriptions and features:

- **Failed devices** – Review the `zpool status -l` output to identify the physical location of the failed device and replace it. For information about replacing a failed disk, see "Replacing or Repairing a Damaged Device" in *Managing ZFS File Systems in Oracle Solaris 11.3*.
- **Failed device notification** – You can configure the `smtp-notify` service to send email notifications in response to various fault management events, such as when a hardware component has been diagnosed as faulty. See the notification parameters section of `smf(5)`.

  By default, some notifications are set up automatically to be sent to the `root` user. If you add an alias for your user account as `root` in the `/etc/aliases` file, you will receive email notifications.

- **Moving devices** – Devices that are part of a ZFS storage pool contain a device ID if the device driver creates or fabricates device IDs. Like all file systems, ZFS has a very close relationship with its underlying devices. If you attempt to upgrade a system's firmware, move a pool device to a different controller, or change a device's cabling, you might consider exporting the pool first. If the device ID does not follow the device change, which can happen with non-Oracle hardware, then the pool and pool data might become unavailable. In general, Oracle's Sun hardware can recover if a device is changed under a live pool because these drivers fully support device IDs. However, you might consider exporting the pool before making any hardware changes.

See Chapter 11, “Oracle Solaris ZFS Troubleshooting and Pool Recovery” in *Managing ZFS File Systems in Oracle Solaris 11.3*.

COMSTAR Replaces iSCSI Target Daemon

Oracle Solaris 10 uses the iSCSI target daemon, the `iscsitadm` command, and the ZFS `shareiscsi` property to configure iSCSI LUNs.

COMSTAR (Common Multiprotocol SCSI Target) features provide the following components:

- Support for different types of SCSI targets, not just the iSCSI protocol.
- ZFS volumes are used as backing store devices for SCSI targets by using one or more of COMSTAR's supported protocols.

Note - Although the iSCSI target in COMSTAR is a functional replacement for the iSCSI target daemon, no upgrade or update path exists for converting your iSCSI LUNs to COMSTAR LUNs.

Both the iSCSI target daemon and the `shareiscsi` property are not available in Oracle Solaris 11.

Use the following commands to manage iSCSI targets and LUNs:

- `itadm` – Manages SCSI targets.
- `srptadm` – Manages SCSI RDMA Protocol (SRP) target ports.
- `stmfadm` – Manages SCSI LUNs. Rather than setting a special iSCSI property on the ZFS volume, create the volume and use the `stmfadm` command to create the LUN.

See Chapter 8, “Configuring Storage Devices With COMSTAR” in *Managing Devices in Oracle Solaris 11.3*.

♦ ♦ ♦ CHAPTER 5

Managing File Systems

This chapter provides information about managing file systems in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

File System Changes

The file systems in Oracle Solaris 11 are very similar to Oracle Solaris 10 file systems. The following table describes the file systems that are supported in this release.

TABLE 5 File Systems That Are Supported in Oracle Solaris 11

File System Type	Supported File Systems
Disk-based file systems	HSFS, PCFS, UDFS, UFS, and ZFS
Network-based file systems	NFS and SMB
Virtual file systems	CTFS, FIFOFS, MNTFS, NAMEFS OBJFS, SHAREFS, SPECFS, and SWAPFS
Temporary file system	TMPFS
Loopback file system	LOFS
Process file system.	PROCFS

The general file system differences are as follows:

- CacheFS is not available in Oracle Solaris 11.
- ZFS is the default root file system.
- UFS is a supported legacy file system, but it is not supported as a bootable root file system.

- The legacy Solaris Volume Manager product is supported, but you cannot boot from a Solaris Volume Manager root device.
- ZFS uses a separate ZFS volume for swap and dump devices. UFS can use a single slice for both swap and dump devices.

Root File System Requirements

The root file system hierarchy is almost identical to systems that are running Oracle Solaris 10 with a ZFS root file system. A ZFS root pool contains a ZFS file system with separate directories of system-related components, such as `etc`, `usr`, and `var`, that must be available for the system to function correctly.

- After you install a system, the root of the Oracle Solaris file system is mounted, which means files and directories are accessible.
- All subdirectories of the root file system that are part of the Oracle Solaris OS, with the exception of `/var`, must be contained in the same file system as the root file system.
- A separate `/var` file system is created automatically for a global zone and a non-global zone in Oracle Solaris 11.
- A `rpool/VARSHARE` file system is mounted at `/var/share` by default. The purpose of this file system is to share file systems across boot environments so that the amount of space that is needed in the `/var` directory for all BEs is reduced.

  ```
  # ls /var/share
  audit  cores  crash  mail
  ```

  Symbolic links are automatically created from `/var` to the `/var/share` components previously listed for compatibility purposes. This file system generally requires no administration except to ensure that `/var` components do not fill up the root file system. During a system upgrade, it might take some time to migrate data from the original `/var` directory to the `/var/share` directory.
- In addition, all Oracle Solaris OS components must reside in the root pool, with the exception of the swap and dump devices.
- A default swap device and a dump device are automatically created as ZFS volumes in the root pool when a system is installed. You *cannot* use the same volume for both swap and dump devices. Also, you *cannot* use swap files in a ZFS root environment. See “Swap and Dump Device Configuration Changes” on page 49.

Mounting File Systems

Review the following considerations when mounting file systems:

- Similar to Oracle Solaris 10 releases, a ZFS file system is mounted automatically when it is created. No need exists to edit the `/etc/vfstab` file to mount local ZFS file systems.
- If you want to create and mount a local legacy UFS file system to be mounted at boot time, you will need to add an entry to the `/etc/vfstab` file as in previous Oracle Solaris releases.
- If you want to mount a remote file system at boot time, you will need to add an entry to the `/etc/vfstab` file and start the following service:

  ```
  # svcadm enable svc:/network/nfs/client:default
  ```

  Otherwise, the file system is not mounted at boot time.

Managing ZFS File Systems

The following ZFS file system features (not available in Oracle Solaris 10) are available in Oracle Solaris 11:

- **ZFS file system encryption** – You can encrypt a ZFS file system when it is created. See Chapter 9, “Managing Security”.
- **ZFS file system deduplication** – For important information about determining whether your system environment can support ZFS data deduplication, see “ZFS Data Deduplication Requirements” on page 67.
- **ZFS file system sharing syntax changes** – Includes both NFS and SMB file system sharing changes. See“ZFS File System Sharing Changes” on page 66.
- **ZFS man page changes** – The `zfs.1m` man page has been revised so that core ZFS file system features remain in the `zfs.1m` page, but delegated administration, encryption, and share syntax and examples are covered in the following pages:
  - `zfs_allow`(1M)
  - `zfs_encrypt`(1M)
  - `zfs_share`(1M)
- **ZFS root pool setup simplified** – Support for Unified Archives in Oracle Solaris makes root pool recovery setup much easier than in previous releases. See *Using Unified Archives for System Recovery and Cloning in Oracle Solaris 11.3*.
- **ZFS send stream monitoring** – You can monitor the progress of a ZFS stream transmission in real time. See “Monitoring ZFS Pool Operations” in *Managing ZFS File Systems in Oracle Solaris 11.3*.

- **ZFS temporary pool names** – You can create or import a pool with a temporary pool name in a shared storage or recovery scenario. See “Importing a Pool With a Temporary Name” in *Managing ZFS File Systems in Oracle Solaris 11.3*.

Displaying ZFS File System Information

After installing your system, review the ZFS storage pool and ZFS file system information.

Display ZFS storage pool information with the `zpool status` command.

Display ZFS file system information with the `zfs list` command.

See “Reviewing the Initial BE After an Installation” on page 80.

Resolving ZFS File System Space Reporting Issues

The `zpool list` and `zfs list` commands are more improved than the `df` and `du` commands for determining available pool and file system space. With the legacy commands, you cannot easily discern between pool and file system space, nor do the legacy commands account for space that is consumed by descendant file systems or snapshots.

For example, the following root pool (`rpool`) has 5.46 GB allocated and 68.5 GB free:

```
# zpool list rpool
NAME   SIZE  ALLOC   FREE  CAP  DEDUP  HEALTH  ALTROOT
rpool   74G  5.46G  68.5G   7%  1.00x  ONLINE  -
```

If you compare the pool space accounting with the file system space accounting by reviewing the `USED` columns of your individual file systems, you can see that the pool space is accounted for, as shown in the following example:

```
# zfs list -r rpool
NAME                     USED  AVAIL  REFER  MOUNTPOINT
rpool                   5.41G  67.4G  74.5K  /rpool
rpool/ROOT              3.37G  67.4G    31K  legacy
rpool/ROOT/solaris      3.37G  67.4G  3.07G  /
rpool/ROOT/solaris/var   302M  67.4G   214M  /var
rpool/dump              1.01G  67.5G  1000M  -
rpool/export            97.5K  67.4G    32K  /rpool/export
rpool/export/home       65.5K  67.4G    32K  /rpool/export/home
rpool/export/home/admin 33.5K  67.4G  33.5K  /rpool/export/home/admin
rpool/swap              1.03G  67.5G  1.00G  -
```

Resolving ZFS Storage Pool Space Reporting Issues

The SIZE value that is reported by the `zpool list` command is generally the amount of physical disk space in the pool, but varies depending on the pool's redundancy level. The `zfs list` command lists the usable space that is available to file systems, which is disk space minus ZFS pool redundancy metadata overhead, if any. See the following examples for more information.

- **Non-redundant storage pool** – Created with one 136-GB disk, the `zpool list` command reports `SIZE` and initial `FREE` values as 136 GB. The initial `AVAIL` space that is reported by the `zfs list` command is 134 GB, which is due to a small amount of pool metadata overhead, as shown in the following example:

```
# zpool create tank c0t6d0
# zpool list tank
NAME   SIZE  ALLOC   FREE    CAP  DEDUP  HEALTH  ALTROOT
tank   136G  95.5K   136G     0%  1.00x  ONLINE  -
# zfs list tank
NAME   USED  AVAIL  REFER  MOUNTPOINT
tank    72K   134G    21K  /tank
```

- **Mirrored storage pool** – Created with two 136-GB disks, the `zpool list` command reports `SIZE` as 136 GB and initial `FREE` value as 136 GB. This reporting is referred to as the *deflated* space value. The initial `AVAIL` space that is reported by the `zfs list` command is 134 GB, which is due to a small amount of pool metadata overhead, as shown in the following example:

```
# zpool create tank mirror c0t6d0 c0t7d0
# zpool list tank
NAME   SIZE  ALLOC   FREE    CAP  DEDUP  HEALTH  ALTROOT
tank   136G  95.5K   136G     0%  1.00x  ONLINE  -
# zfs list tank
NAME   USED  AVAIL  REFER  MOUNTPOINT
tank    72K   134G    21K  /tank
```

- **RAID-Z storage pool** – Created with three 136-GB disks, the `zpool list` commands reports `SIZE` as 408 GB and initial `FREE` value as 408 GB. This reporting is referred to as the *inflated* disk space value, which includes redundancy overhead, such as parity information. The initial `AVAIL` space that is reported by the `zfs list` command is 133 GB, which is due to the pool redundancy overhead. The following example creates a RAIDZ-2 pool:

```
# zpool create tank raidz2 c0t6d0 c0t7d0 c0t8d0
# zpool list tank
NAME   SIZE  ALLOC   FREE    CAP  DEDUP  HEALTH  ALTROOT
tank   408G   286K   408G     0%  1.00x  ONLINE  -
```

```
# zfs list tank
NAME   USED  AVAIL  REFER  MOUNTPOINT
tank  73.2K   133G  20.9K  /tank
```

Making ZFS File Systems Available

Making ZFS file systems available is similar to Oracle Solaris 10 releases in the following ways:

- A ZFS file system is mounted automatically when it is created and then remounted automatically when the system is booted.
- You do not have to modify the `/etc/vfstab` file to mount a ZFS file system, unless you create a legacy mount for ZFS file system. Mounting a ZFS file system automatically is recommended over using a legacy mount.
- You do not have to modify the `/etc/dfs/dfstab` file to share file systems. See "ZFS File System Sharing Changes" on page 66.
- Similar to a UFS root, the swap device must have an entry in the `/etc/vfstab` file.
- You can share file systems between Oracle Solaris 10 systems and Oracle Solaris 11 systems by using NFS sharing.
- You can share file systems between Oracle Solaris 11 systems by using NFS or SMB sharing.
- You can export ZFS storage pools from an Oracle Solaris 10 system and then import them to an Oracle Solaris 11 system.

Monitoring File Systems

You can use the `fsstat` command to monitor file systems and report about file system operations. There are several options that report different kinds of activity. For example, you can display information by mount point or by file system type. In the following example, the `fsstat` command displays all of the ZFS file system operations from the time that the ZFS module was initially loaded:

```
$ fsstat zfs
new  name   name  attr  attr lookup rddir  read read  write write
file remov  chng   get   set    ops   ops   ops bytes   ops bytes
268K  145K 93.6K 28.0M 71.1K   186M 2.74M 12.9M 56.2G 1.61M 9.46G zfs
```

See `fsstat`(1M) for other examples.

Managing Memory Between ZFS and Applications

The `user_reserve_hint_pct tunable` parameter provides a *hint* to the system about application memory usage. This hint is used to limit the growth of ZFS Adaptive Replacement Cache (ARC) cache so that more memory can be made available for applications. For information about using this parameter, see *Memory Management Between ZFS and Applications in Oracle Solaris 11.2* (Doc ID 1663862.1) at `https://support.oracle.com/`.

NFS `nfsmapid` Syntax Changes

The syntax for modifying the `nfsmapid` service that maps NFSv4 user and group IDs by using the `passwd` and `group` entries in the `/etc/nsswitch.conf` file has changed.

The `nfsmapid` service is as follows:

```
# svcs mapid
STATE          STIE    FMRI
online         Apr_25   svc:/network/nfs/mapid:default
```

You would modify the service instance as follows:

```
# svccfg -s svc:/network/nfs/mapid:default
svc:/network/nfs/mapid:default> listprop
nfs-props                          application
nfs-props/nfsmapid_domain         astring     fooold.com
general                            framework
general/complete                  astring
general/enabled                   boolean     false
restarter                          framework           NONPERSISTENT
restarter/logfile                 astring     /var/svc/log/network-nfs-mapid:default.log
restarter/contract                count       137
restarter/start_pid               count       1325
restarter/start_method_timestamp  time        1366921047.240441000
restarter/start_method_waitstatus integer     0
restarter/auxiliary_state         astring     dependencies_satisfied
restarter/next_state              astring     none
restarter/state                   astring     online
restarter/state_timestamp         time        1366921047.247849000
general_ovr                        framework           NONPERSISTENT
general_ovr/enabled               boolean     true
svc:/network/nfs/mapid:default> setprop nfs-props/nfsmapid_domain = newfoo.com
svc:/network/nfs/mapid:default> listprop
nfs-props                          application
nfs-props/nfsmapid_domain         astring     foonew.com
```

```
.
.
.
svc:/network/nfs/mapid:default> exit
# svcadm refresh svc:/network/nfs/mapid:default
```

ZFS File System Sharing Changes

In Oracle Solaris 10, you set the `sharenfs` or `sharesmb` property to create and publish a ZFS file system share. Or, you can use the legacy `share` command. In Oracle Solaris 11 11/11, file sharing was enhanced and the command syntax changed. See "Legacy ZFS Sharing Syntax" in *Managing ZFS File Systems in Oracle Solaris 11.3* for details of this change.

Starting with Oracle Solaris 11.1, the following ZFS file sharing enhancements were made:

- Share syntax is simplified. You share a file system by setting the `share.nfs` or `share.smb` property as follows:

  ```
  # zfs set share.nfs=on tank/home
  ```

- Support for better inheritance of share properties to descendent file systems. In the previous example, the `share.nfs` property value is inherited to any descendent file systems, as shown in the following example:

  ```
  # zfs create tank/home/userA
  # zfs create tank/home/userB
  ```

- Specify additional property values or modify existing property values on any existing file system shares as follows:

  ```
  # zfs set share.nfs.nosuid=on tank/home/userA
  ```

  These additional file sharing improvements are associated with pool version 34. See "New ZFS Sharing Syntax" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

ZFS Sharing Migration Issues

Review the following share transition issues:

- **Upgrading an Oracle Solaris 11 system to a subsequent Oracle Solaris 11 release** – ZFS shares will be incorrect if you boot back to an older BE due to property changes in this release. Non-ZFS shares are unaffected. If you plan to boot back to an older BE, save a copy of the existing share configuration prior to the `pkg update` operation so that you can restore the share configuration on the ZFS datasets.

Note the following additional information:

- In the older BE, use the `sharemgr show -vp` command to list all shares and their configuration.
- Use the `zfs get sharenfs` *filesystem* command and the `zfs sharesmb` *filesystem* commands to obtain the values of the sharing properties.
- If you boot back to an older BE, reset the `sharenfs` and `sharesmb` properties to their original values.

- **Legacy unsharing behavior** – Using the `unshare -a` command or the `unshareall` command unpublishes a share, but the command does not update the SMF shares repository. If you try to re-share the existing share, the shares repository is checked for conflicts, and an error message is displayed.

ZFS Data Deduplication Requirements

You can use the deduplication (`dedup`) property to remove redundant data from your ZFS file systems. If a file system has the `dedup` property enabled, duplicate data blocks are removed synchronously. The result is that only unique data is stored, and common components are shared between files, as shown in the following example:

```
# zfs set dedup=on tank/home
```

Do not enable the `dedup` property on file systems that reside on production systems until you perform the following steps to determine if your system can support data deduplication.

1. Determine if your data would benefit from deduplication space savings. If your data is not dedupable, there is no point in enabling `dedup`. Note that running the following command is very memory intensive:

```
# zdb -S tank
Simulated DDT histogram:
bucket              allocated                       referenced
______   ______________________________   ______________________________
refcnt   blocks   LSIZE   PSIZE   DSIZE   blocks   LSIZE   PSIZE   DSIZE
------   ------   -----   -----   -----   ------   -----   -----   -----
1    2.27M    239G    188G    194G    2.27M    239G    188G    194G
2     327K   34.3G   27.8G   28.1G     698K   73.3G   59.2G   59.9G
4    30.1K   2.91G   2.10G   2.11G     152K   14.9G   10.6G   10.6G
8    7.73K    691M    529M    529M    74.5K   6.25G   4.79G   4.80G
16       673   43.7M   25.8M   25.9M    13.1K    822M    492M    494M
32       197   12.3M   7.02M   7.03M    7.66K    480M    269M    270M
64        47   1.27M    626K    626K    3.86K    103M   51.2M   51.2M
```

```
128       22    908K    250K    251K    3.71K    150M   40.3M   40.3M
256        7    302K     48K   53.7K    2.27K   88.6M   17.3M   19.5M
512        4    131K   7.50K   7.75K    2.74K    102M   5.62M   5.79M
2K         1      2K      2K      2K    3.23K   6.47M   6.47M   6.47M
8K         1    128K      5K      5K    13.9K   1.74G   69.5M   69.5M
Total   2.63M    277G    218G    225G    3.22M    337G    263G    270G

dedup = 1.20, compress = 1.28, copies = 1.03, dedup * compress / copies = 1.50
```

If the estimated `dedup` ratio is greater than 2, then you might see deduplication space savings.

In this example, the `dedup` ratio (`dedup = 1.20`) is less than 2, so enabling deduplication is discouraged.

2. Make sure your system has enough memory to support deduplication as follows:
   - Each in-core deduplication table entry is approximately 320 bytes.
   - Multiply the number of allocated blocks times 320:

     ```
     in-core DDT size = 2.63M x 320 = 841.60M
     ```
3. Deduplication performance is best when the deduplication table fits into memory. If the table has to be written to disk, then performance will decrease. If you enable deduplication on your file systems without sufficient memory resources, system performance might degrade during file system related operations. For example, removing a large dedup-enabled file system without sufficient memory resources might impact system performance.

Considering ZFS Backup Features

- There are no `ufsdump` and `ufsrestore` command equivalents – You can use a combination of features to provide file system backup features.
- Create ZFS snapshots of important file systems and clone file systems that you can then modify as needed.
- Send and receive ZFS snapshots to a remote system.
- Save ZFS data with archive utilities, such as `tar`, `cpio`, and `pax`, or enterprise backup products.

Migrating File System Data to ZFS File Systems

Consider the following suggested best practices for migrating data to systems that are running Oracle Solaris 11.

UFS to ZFS Data Migration Best Practices

Follow these guidelines:

- Do not mix UFS directories and ZFS file systems in the same file system hierarchy because this model is confusing to administer and maintain.
- Do not mix NFS legacy shared ZFS file systems and ZFS NFS shared file systems because this model is difficult to maintain. Consider using only ZFS NFS shared file systems.
- Use the shadow migration feature to migrate existing UFS data over NFS to ZFS file systems.

Migrating Data With ZFS Shadow Migration

You can use the ZFS shadow migration tool to migrate data from an existing file system to a new file system. A *shadow* file system is created and that file system then pulls data from the original source as necessary.

You can use the shadow migration feature to migrate file systems as follows:

- A local or remote ZFS file system to a target ZFS file system
- A local or remote UFS file system to a target ZFS file system

Shadow migration is a process that pulls the data to be migrated and then does the following:

- Creates an empty ZFS file system.
- Sets the `shadow` property on an empty ZFS file system, which is the target (or shadow) file system, to point to the file system to be migrated, as shown in the following example:

  ```
  # zfs create -o shadow=nfs://system/export/home/ufsdata users/home/shadow2
  ```

- Data from the file system to be migrated is copied over to the shadow file system. For step-by-step instructions, see "Migrating ZFS File Systems" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

Review the following considerations when migrating file systems:

- The file system to be migrated must be set to read-only. If the file system is not set to read-only, in progress changes might not be migrated.
- The target file system must be completely empty.
- If the system is rebooted during a migration, the migration continues after the reboot.
- Access to directory content that is not completely migrated or access to file content that is not completely migrated is blocked until the entire content is migrated.
- If you want the UID, GID, and ACL information to be migrated to the shadow file system during an NFS migration, make sure that the name service information is accessible

between the local and remote systems. You might consider copying a subset of the file system data to be migrated for a test to determine whether all of the ACL information is migrated properly before completing a large migration of data over NFS.

- Migrating file system data over NFS can be slow, depending on your network bandwidth.
- Monitor file system data migration with the `shadowstat` command.

Migrating UFS Data to a ZFS File System

You can also use the `ufsrestore` command to restore a previous `ufsdump` dump, as shown in the following example:

```
# mount -F nfs rsystem:/export/ufsdata /tank/legacyufs
# ls /tank/legacyufs
ufsdump-a
# zfs create tank/newzfs
# cd /tank/newzfs
# ufsrestore rvf /tank/legacyufs/ufsdump-a
```

If the original UFS file system data includes POSIX-draft ACLs, it is translated into NFSv4 ACLs. See "Using Access Control Lists" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.

♦ ♦ ♦ CHAPTER 6

Managing Software and Boot Environments

This chapter provides information about how to manage software and boot environments (BEs) in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Software Package Changes

The Image Packaging System (IPS) is a framework that provides the capability for software lifecycle management, which includes installation, upgrade, and the removal of packages. IPS uses packaging mechanisms that are significantly different than the legacy SVR4 packaging mechanism that is used in Oracle Solaris 10.

An IPS package is a collection of directories, files, links, drivers, dependencies, groups, users, and license information in a defined format. This collection represents the installable objects of a package. Packages have attributes, such as package name and description. IPS packages are stored in IPS package repositories that are populated by IPS publishers. See Chapter 1, "Introduction to the Image Packaging System" in *Adding and Updating Software in Oracle Solaris 11.3*.

IPS includes a suite of `pkg` commands that enable you to list, search, install, update, and remove software packages. See Chapters 2-4 in *Adding and Updating Software in Oracle Solaris 11.3*. IPS commands also enable you to manage package publishers, copy or create package repositories, configure the default path for an application that has multiple installed versions, and set image properties. See Chapter 4, "Maintaining Your Local IPS Package Repository" in *Copying and Creating Package Repositories in Oracle Solaris 11.3* and Chapter

5, “Configuring Installed Images” in *Adding and Updating Software in Oracle Solaris 11.3* for more information.

Oracle Solaris 10 SVR4 and IPS Package Comparison

Review the following information about software packaging changes:

- The `SUNW` prefix for package names is no longer used. With the introduction of IPS, all software packages are renamed. A set of mappings has been added to the former SVR4 package database for compatibility. The mappings ensure that package dependencies are met for administrators who want to install a legacy SVR4 package.
- Certain SVR4 package commands, such as `pkgadd`, are retained for administering legacy SVR4 packages, but the primary package installation and update interface is the `pkg(1)` set of commands. If you previously used the `pkgadd` command to install a particular package, you can check whether that package is available as an IPS package. The IPS package name will most likely be different.

  Locate a specific SVR4 package as follows:

```
$ pkg info -g http://pkg.oracle.com/solaris/release/ SUNWcsl
   Name: SUNWcsl
        Summary:
          State: Not installed (Renamed)
     Renamed to: system/library@0.5.11-0.133
                 consolidation/osnet/osnet-incorporation
      Publisher: solaris
        Version: 0.5.11
  Build Release: 5.11
         Branch: 0.133
Packaging Date: Wed Oct 27 18:35:58 2010
           Size: 0.00 B
           FMRI: pkg://solaris/SUNWcsl@0.5.11,5.11-0.133:20101027T183558Z
```

  The previous output shows that the SVR4 `SUNWcsl` package is renamed to the IPS `system/library` package. Determine If the IPS package is installed as follows:

```
$ pkg list system/library
NAME (PUBLISHER)                                  VERSION                    IFO
system/library                                    0.5.11-0.175.3.0.0.11.0    i--
```

  The previous output indicates that the `system/library` package is already installed. If the package was not installed, you would install the package as follows:

```
$ pkg install system/library
```

- If an SVR4 package is available as an IPS package, install the IPS package rather than the SVR4 package. Installing the IPS package ensures that only versions that are compatible with the rest of the image can be installed and that dependencies are automatically checked and updated. See *Adding and Updating Software in Oracle Solaris 11.3*.

  In the previous example, even if you attempted to install the SVR4 package, the `system/library` IPS package is automatically installed. However, in this example, since the package is already installed, the command returns the following message:

  ```
  $ pkg install SUNWcsl
  No updates necessary for this image.
  ```

- Certain SVR4 package commands, for example, `patchadd`, are no longer available. Instead, use the IPS `pkg update` command. When you use this command, any package dependencies are automatically resolved.
- IPS package names use a Fault Manager Resource Identifier (FMRI) naming style. Package names are also hierarchical instead of abbreviated. To reiterate, the core system library package in Oracle Solaris 10 is `SUNWcsl` but the IPS name is `system/library`. The FMRI format of `system/library` is similar to the following:

  ```
  pkg://solaris/system/library@0.5.11,5.11-0.175.3.0.0.11.0:20141123T202303Z
  ```

  See "Fault Management Resource Identifiers" in *Adding and Updating Software in Oracle Solaris 11.3*.

Note - Due to organizational restructuring of the files that are delivered with each package, there is not an exact one-to-one mapping of Oracle Solaris 10 package names to Oracle Solaris 11 package names.

- Oracle Solaris 10 packages are split into development, documentation, and runtime components. In Oracle Solaris 11, all of these components are delivered in one package. You can use the `pkg change-facet` command to exclude certain components such as man pages or header files. See "Controlling Installation of Optional Components" in *Adding and Updating Software in Oracle Solaris 11.3*.
- SVR4 packaging and patch tools are still supported in Oracle Solaris 10 Containers. These Oracle Solaris 10 branded, non-global zones run on Oracle Solaris 11 by using zones and branded zones. See "Oracle Solaris Zones Features" on page 150.

The following table compares SVR4 package and patch commands with IPS package commands.

TABLE 6 SVR4 and IPS Package Command Equivalents

SVR4 Package Command	IPS Package Command Equivalent
`pkgadd`	`pkg install`
`patchadd`	`pkg update`
`pkgrm`	`pkg uninstall`
`pkgadm addcert`, `pkgadm removecert`	`pkg set-publisher -k`, `-c`, `--approve-ca-cert`, `--revoke-ca-cert`, `unset-ca-cert`
`pkginfo`, `pkgchk -l`	`pkg info`, `pkg list`, `pkg contents`, `pkg search`
`pkgchk`	`pkg verify`, `pkg fix`, `pkg revert`

IPS Installation Package Groups

Oracle Solaris 10 installation methods provide software package clusters that install a group of packages based on the system's purpose, for example, a minimal network, desktop, developer, and all for servers. Oracle Solaris 11 provides group packages that are appropriate for the following: large server, small server or non-global zone, minimal server, and a graphical desktop environment. Each of these group packages installs different sets of packages on the system. All of the `*group/system/solaris*` packages install the `group/system/solaris-core-platform` package.

Display package group information as follows:

```
$ pkg list -as '*group/system/solaris*'
```

Determine which Oracle Solaris package group is currently installed on your system as follows:

```
# pkg list group/system/solaris-\*
```

IPS also includes other meta and group packages that you can install on your system to provide a trusted desktop or multi-user desktop. If you want to install most packages, similar to installing the Solaris 10 `SUNWCall` package cluster, consider installing the `group/system/solaris-large-server` package group.

You can display the contents of package groups as follows:

```
$ pkg contents -ro type,fmri -t depend group-package-name
```

For a complete listing of the packages that are part of each package group, see *Oracle Solaris 11.3 Package Group Lists*.

The dependencies that are listed in the output of the `pkg contents` command often have individual dependencies, which means that many more packages are actually installed on the system. For a complete list, use the following command:

```
# pkg exact-install -nv --require-new-be entire group-package-name
```

For additional information, see "Listing All Installable Packages in a Group Package" in *Adding and Updating Software in Oracle Solaris 11.3*.

Displaying Information About Software Packages

To display information about software packages, refer to the following examples. No special privileges are required to display information about packages.

List the packages that are currently installed on your system:

```
$ pkg list | more
```

Determine whether a specific package is installed in the current image and whether an update is available.

```
$ pkg list amp
pkg list: no packages matching 'amp' installed
```

Display more information about a package that is not installed. Use the `-r` option to query the package repository, as follows:

```
$ pkg info -r amp
          Name: amp
       Summary:
         State: Not installed (Renamed)
    Renamed to: web/amp@0.5.11-0.133
                consolidation/sfw/sfw-incorporation
     Publisher: solaris
       Version: 0.5.11
        Branch: 0.133
Packaging Date: Wed Oct 27 18:31:05 2010
          Size: 0.00 B
          FMRI: pkg://solaris/amp@0.5.11-0.133:20101027T183105Z

          Name: group/feature/amp
       Summary: AMP (Apache, MySQL, PHP) Deployment Kit for Oracle Solaris
   Description: Provides a set of components for deployment of an AMP (Apache, MySQL,
PHP) stack on Oracle Solaris
      Category: Meta Packages/Group Packages(org.opensolaris.category.2008)
                Web Services/Application and Web Servers (org.opensolaris.category.2008)
         State: Not installed
     Publisher: solaris
       Version: 0.5.11
```

```
 Build Release: 5.11
        Branch: 0.175.3.0.0.18.0
Packaging Date: Sun Mar 15 19:45:04 2015
          Size: 5.46 kB
          FMRI: pkg://solaris/group/feature/amp@0.5.11,5.11-0.175.3.0.0.18.0:
20150315T194504Z

          Name: web/amp
       Summary:
         State: Not installed (Renamed)
    Renamed to: group/feature/amp@0.5.11-0.174.0.0.0.0.0
                consolidation/ips/ips-incorporation
     Publisher: solaris
       Version: 0.5.11
        Branch: 0.174.0.0.0.0.0
Packaging Date: Wed Sep 21 19:15:02 2011
          Size: 5.45 kB
          FMRI: pkg://solaris/web/amp@0.5.11-0.174.0.0.0.0.0:20110921T191502Z
```

If you know the name of the tool that you want to install, but not the name of the package, use the `search` subcommand in one of the following ways:

```
$ pkg search /usr/bin/emacs
INDEX      ACTION VALUE         PACKAGE
path       file   usr/bin/emacs pkg:/editor/gnu-emacs@24.3-0.175.3.0.0.11.0



$ pkg search file::emacs
INDEX      ACTION VALUE         PACKAGE
basename   file   usr/bin/emacs pkg:/editor/gnu-emacs@24.3-0.175.3.0.0.11.0
```

Updating the Software on an Oracle Solaris System

With IPS, you can update all of the packages on your system that have available updates. Or, you can update individual packages that are not constrained by package dependencies or image policy. If a package is constrained, a message indicating what constraint is preventing the installation or update is provided. Package constraints generally represent a dependency or a version issue.

For some package installations or updates, a clone or backup BE is automatically created. If a clone (new) BE is created, the changes are made in the clone and the current BE is not touched. To see the changes, reboot the new clone BE. If you are not satisfied with the changes, you can reboot the original BE. If a backup BE is created, the changes are made in the current BE and

the backup BE becomes a clone of the current BE before the changes were made. If you are not satisfied with the changes, you can reboot the backup BE. You can specify `pkg` command options and image policy settings to explicitly request a new or backup BE. See *Adding and Updating Software in Oracle Solaris 11.3* and the `pkg`(1) man page.

The following options are available:

- **Adding software packages after an installation** – To add packages, use the `pkg install` command. See Chapter 3, "Installing and Updating Software Packages" in *Adding and Updating Software in Oracle Solaris 11.3*.
- **Adding a selected package or packages after an installation** – You can update just one package or a few packages by specifying the package or packages on the command line, as shown in the following example. Note that other packages might be automatically updated or installed due to existing dependencies.

  ```
  # pkg update tcsh
  ```

- **Updating all of the packages on your installed system** – Update all of the packages on your system that have available updates as follows:

  ```
  # pkg update
  ```

  If you want to display information about which software packages will be installed without actually installing the packages, specify the `-n` and `-v` options with the `pkg update` command:

  ```
  # pkg update -nv
  ```

  Depending on your package repository content, your system could be updated automatically from one Oracle Solaris 11 release to a subsequent Oracle Solaris 11 release. For more information about controlling a system upgrade, see Chapter 4, "Updating or Upgrading an Oracle Solaris Image" in *Adding and Updating Software in Oracle Solaris 11.3*.

  Display a list of installed packages that have available updates as follows:

  ```
  # pkg list -u  '*jre*'NAME (PUBLISHER)
  VERSION                   IFOruntime/java/jre-7
  1.7.0.72.14               i--$pkg list -n jre-7NAME (PUBLISHER)
  VERSION                   IFOruntime/java/jre-7
  1.7.0.76.13               ---$ pkg list -af jre-7NAME (PUBLISHER)
  VERSION                   IFOruntime/java/jre-7
  1.7.0.76.13               ---runtime/java/jre-7
  1.7.0.72.14               i--runtime/java/jre-7
  1.7.0.65.17               ---runtime/java/jre-7
  1.7.0.60.19               ---runtime/java/jre-7
  1.7.0.55.13               ---runtime/java/jre-7
  1.7.0.51.34               ------...
  ```

- **Install package updates that deliver fixes** – Apply Support Repository Updates (SRUs) as needed. SRUs occur on a regular basis. Note that SRUs apply to the current Oracle Solaris 11 release *only* and are generally not provided for previous releases.

Installing Maintenance Updates on an Oracle Solaris 11 System

If you have an active Oracle support plan, you have access to the `support` package repository so that you can routinely update your Oracle Solaris 11 systems. Updates to the `support` repository are called Support Repository Updates (SRUs) and they occur on a regular basis. SRUs take the place of maintenance updates or patch bundles that are available for Oracle Solaris 10 releases. Subsequent Oracle Solaris 11 releases are made available in the `support` repository or a `release` repository that provides the currently available OS. Note that SRUs apply to the current release and are generally not provided for previous Oracle Solaris 11 releases. See "How to Configure Access to the Oracle Solaris Support Repository" on page 78.

If you need to access an IPS repository on a system that has zones installed by using `https_proxy` and `http_proxy`, see "Proxy Configuration on a System That Has Installed Zones" in *Creating and Using Oracle Solaris Zones*. See also "Specifying a Proxy" in *Adding and Updating Software in Oracle Solaris 11.3*.

For more information about copying and creating package repositories, see *Copying and Creating Package Repositories in Oracle Solaris 11.3*.

For more information about choosing the best way to update your system images, see Chapter 4, "Updating or Upgrading an Oracle Solaris Image" in *Adding and Updating Software in Oracle Solaris 11.3*.

▼ How to Configure Access to the Oracle Solaris Support Repository

1. **Log into the following site:**

   `https://pkg-register.oracle.com/`

2. **Select Oracle Solaris 11 Support option from the Product list, then click the Submit button to accept the license agreement.**

3. **To download the SSL key and certificate, follow the directions on the download page.**

4. **Set the Oracle Solaris publisher to the `support` repository.**

```
# pkg set-publisher \
-k /var/pkg/ssl/Oracle_Solaris_11_Support.key.pem \
-c /var/pkg/ssl/Oracle_Solaris_11_Support.certificate.pem \
-g https://pkg.oracle.com/solaris/support solaris
```

Managing Boot Environments

Boot environments (BEs) are bootable instances of an image. In Oracle Solaris 11, you use the `pkg update` command to update a BE and the `beadm` command to create, list, rename, activate, and remove BEs.

Tools for Managing Boot Environments

The `beadm` utility replaces the `lu` set of commands for managing ZFS BEs. In most cases, the `pkg update` command creates and updates a clone BE. However, the command is not guaranteed to create a new or backup BE in every instance. Use the appropriate `pkg update` command options to specify a desired outcome. Also, new and backup BEs behave differently. For new BEs, updates are made in the new BE. Whereas, if a backup BE is created, updates are made in the current BE.

TABLE 7 Comparing Boot Environment Command Syntax

Oracle Solaris 10 Syntax	Oracle Solaris 11 Syntax	Description
`lucreate -n` *newBE*	`beadm create` *newBE*	Create a new BE
`lustatus`	`beadm list`	Display BE information
`luactivate` *newBE*	`beadm activate` *newBE*	Activate a BE
`ludelete` *BE*	`beadm destroy` *BE*	Destroy an inactive BE
`luupgrade` or `patchadd`	`pkg update`	Upgrade or update a BE

See *Creating and Administering Oracle Solaris 11.3 Boot Environments* and `beadm`(1M).

In most cases, the `pkg update` command, when used with no operands, performs the following actions:

1. Creates a clone of the current BE that is a bootable image.
2. Updates the packages in the clone BE, but does not update any packages in the current BE.
3. Sets the new BE as the default boot option the next time the system is booted. The current BE remains as an alternate boot option.

Reviewing the Initial BE After an Installation

After performing a fresh default Oracle Solaris installation, the following root pool file systems and components are available:

```
# zfs list -r rpool
NAME                      USED  AVAIL  REFER  MOUNTPOINT
rpool                    13.0G   121G  4.58M  /rpool
rpool/ROOT               6.81G   121G    31K  legacy
rpool/ROOT/solaris       6.81G   121G  4.07G  /
rpool/ROOT/solaris/var    364M   121G   207M  /var
rpool/VARSHARE             50K   121G    50K  /var/share
rpool/dump               4.13G   121G  4.00G  -
rpool/export               63K   121G    32K  /export
rpool/export/home          31K   121G    31K  /export/home
rpool/swap               2.06G   121G  2.00G  -
```

▼ How to Update an Oracle Solaris 11 Boot Environment

To update a boot environment, use the `pkg update` command. If a clone (new) BE is created, the changes are made in the clone and the current BE is not touched. By default, the new BE is activated. To see the changes, reboot the new BE. If you are not satisfied with the changes, you can reboot the original BE. As a best practice, use the `pkg update -nv` command first to determine which packages will be updated.

Caution - When you update your BE, you might need to upgrade your root pool version. Make sure you have tested all of the features and that you are satisfied with the current update before upgrading your pool version and updating the BE. For information about upgrading your pool version, see "Upgrading ZFS Storage Pools" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

1. **Display the existing BE information for your system.**

```
# beadm list
```

2. **Update the BE as follows:**

```
# pkg update -nv
```

where the `-nv` options enable you to first determine which packages will be installed without actually installing the packages.

Then, install the packages as follows:

```
# pkg update --be-name meaningfulName
```

When naming a new BE, choose a meaningful name. For example, if there is an existing BE named `solaris`, a new BE called `solaris-1` will be created and automatically activated after the `pkg update` operation completes.

3. **Reboot the system, then, confirm the BE status.**

```
# init 6
.
.
.
# beadm list
```

4. **(Optional) If an error occurs when booting the new BE, activate and boot the previous BE.**

```
# beadm activate previousBE
# init 6
```

If the activated BE does not boot, see "How to Boot From a Backup BE for Recovery Purposes" on page 124.

♦ ♦ ♦ CHAPTER 7

Managing Network Configuration

This chapter provides basic information about managing network configuration in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Note - For a description of the example IP addresses used in this guide, see the `IP address` entry in *Glossary of Networking Terms*.

Network Administration Features

How you configure the network in Oracle Solaris 11 differs from Oracle Solaris 10. For more detailed information about network administration changes in this release, see "Highlights of Network Administration in Oracle Solaris" in *Strategies for Network Administration in Oracle Solaris 11.3*.

The following network administration features (listed alphabetically) are new or have changed:

- **Datalink naming** – Oracle Solaris 11 supports generic naming of datalinks. Generic names are automatically assigned to each datalink on a system by using the `net0`, `net1`, `net`*N* naming convention, depending on the total number of network devices that are on the system.
- **DHCP support** – In addition to the legacy Sun DHCP product, Oracle Solaris 11 supports the Internet Systems Consortium (ISC) DHCP server. This software is not automatically installed on your system. See "Administering DHCP" on page 105.

ISC DHCP support includes new SMF services, new administrative commands, and new configuration files. For details, see "ISC DHCP Server" in *Working With DHCP in Oracle Solaris 11.3*.

- **IP interface and address configuration** – You use the `ipadm` command to manage network configuration at the IP layer (L3) layer of the network protocol stack. The command configures IP interfaces and addresses, as well as other L3 entities, for example, IP network multipathing (IPMP). The `ipadm` command replaces the `ifconfig` command that is used in Oracle Solaris 10.

  The `ipadm` command provides almost equivalent functionality to the `ifconfig` command for configuring IP interfaces and addresses, with the exception that in Oracle Solaris 11, the `ipadm` command is solely used for IP administration. Also, unlike the `ifconfig` command, changes that you make with the `ipadm` command persist across system reboots. Note that you can still use the `ifconfig` in some cases. See "Comparing the `ifconfig` Command to the `ipadm` Command" on page 92. See also the `ifconfig`(5) man page.
- **IPMP changes**– IPMP has a new conceptual model and different commands for managing IPMP configuration. One significant change is that IP interfaces are grouped into a *virtual* IP interface, for example, `ipmp0`. The virtual IP interface serves all of the data IP addresses, while test addresses that are used for probe-based failure detection are assigned to an underlying interface such as `net0`. For more information about these changes, see "How IPMP Works" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.

  Oracle Solaris 11 also uses different commands for managing IPMP configuration. As a result, some configuration tasks are also performed differently. See Chapter 3, "Administering IPMP" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.
- **IP tunnel administration** – IP tunnel administration has changed to be more consistent with datalink administration in Oracle Solaris 11. You create and configure IP tunnels by using the `dladm` command. Tunnels can also use other datalink features that are supported in this release, for example, the ability to assign tunnels more meaningful names. See Chapter 4, "About IP Tunnel Administration" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.
- **Naming and directory services configuration** – This configuration is managed through SMF and not by editing various files within the `/etc` directory. See "Configuring Naming and Directory Services" on page 104.
- **Network configuration during an installation with AI** – Starting with Oracle Solaris 11.2, the `svc:/network/install:default` SMF service includes two new property group types: `ipv4_interface` and `ipv6_interface`. You can create SC profiles that contain property groups with the type `ipv4_interface` and `ipv6_interface`. The `svc:/network/install:default` start method consumes properties of these types and then uses them to configure network interfaces upon the first system boot after an installation. SC profiles

can include an unlimited number of property groups of these types, which enable an administrator to configure multiple network interfaces during installation.

Note that the existing `install_ipv4_interface` and `install_ipv6_interface` property groups for this service continue to be supported. For instructions, see "Configuring Network Interfaces" in *Installing Oracle Solaris 11.3 Systems*.

- **Network diagnostics tools** – You can use the Fault Manager (`fmd`) transport module (`network-monitor`) to perform network diagnostics and monitor network resources. The utility reports conditions that might lead to degraded network functionality. See Chapter 5, "Performing Network Diagnostics With the network-monitor Transport Module Utility" in *Troubleshooting Network Administration Issues in Oracle Solaris 11.3*.
- **Network modes implementation** – Oracle Solaris 11 supports two modes for network configuration: *fixed* and *reactive*. See "About Network Configuration Modes" in *Configuring and Managing Network Components in Oracle Solaris 11.3* for more details.
- **Network monitoring and observability tools** – Oracle Solaris 11 provides several tools for observing network traffic usage, analyzing packet usage, and troubleshooting packet loss. The tool that you use might depend on the feature that you are observing and which layer of the network protocol stack that feature is configured. For more details and examples, see Chapter 2, "Using Observability Tools to Monitor Network Traffic Usage" in *Troubleshooting Network Administration Issues in Oracle Solaris 11.3*.

  Note the following information about when to use some of these tools:

  - Use the `tcpstat` and `ipstat` to obtain information about the network traffic on a server. See "Observing Network Traffic With the ipstat and tcpstat Commands" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.
  - Similar to the `snoop` command, you can use the Wireshark GUI or its command line equivalent, TShark, to troubleshoot networking issues and perform packet analysis. See "Analyzing Network Traffic With TShark and Wireshark" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*
  - The My Traceroute utility (`mtr`) combines the functionality of the `ping` and `traceroute` commands into a single diagnostics tool that sends exploratory packets to a specified host at regular intervals, as well as tracks network hops between the current host and a target host. The utility also records and displays timing information on-screen and constantly updates this information as new packets are sent out and responses are returned.

    To use the `mtr` utility on your Oracle Solaris 11 system, you must first install the `network/mtr` IPS package. See the `mtr`(1M) man page.

  See also "Analyzing Network Traffic With TShark and Wireshark" in *Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.3*.
- **Profile-based network configuration** – The use of profiles enables you to define multiple alternative configurations, each identified by a single profile (referred to as a network configuration profile (NCP)). For example, you could create a profile named `office` for a

notebook PC that configures the system with static IP addresses and DNS server locations. An alternate `home` profile might use DHCP to acquire this information. Two additional commands are used for administering profiles in this release: `netcfg` and `netadm`. See "Network Administration Command Changes" on page 91 for details.

- **Routing configuration** – Use the `route` command to configure a persistent route for a system, default or otherwise. The `route` command replaces the prior method of managing routes through the `/etc/defaultrouter` file. This file is deprecated in Oracle Solaris 11.

  Furthermore, after an installation you cannot determine a system's default route by checking the `/etc/defaultrouter` file. To determine a system's default route after an installation, use the `route -p show` command or the `netstat -nr` command. See "Configuring Persistent Routes" on page 104.
- **Tunables (network parameters) configuration** – The `ipadm` and `dladm` commands also replace the `ndd` command for configuring certain network parameters in this release. See "Comparing the `ndd` Command to the `ipadm` Command" on page 96, "Comparing the `ndd` Command and `driver.conf` Configuration to the `dladm` Command" on page 98, and Chapter 5, "Internet Protocol Suite Tunable Parameters" in *Oracle Solaris 11.3 Tunable Parameters Reference Manual*.

Network Virtualization and Advanced Networking Features

Oracle Solaris 11 supports several network virtualization and advanced networking features. For a detailed description of these features, see "Key Oracle Solaris Network Administration Features" in *Strategies for Network Administration in Oracle Solaris 11.3*.

The following features are new in Oracle Solaris. Several enhancements are for features that were introduced in Oracle Solaris 11 11/11:

- **Communication between VNICs through an external switch** – By using the Oracle Solaris reflective relay feature, you can force traffic between local Oracle Solaris zones or Oracle VMs that share the same underlying physical NIC to always be sent to the physical network instead of the host virtual switch. See "Controlling Switching Between VMs Over the Same Physical Port" in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3*.
- **Displaying multiple MAC addresses that are associated with VNICs** – Multiple MAC addresses are associated with system-created VNICs in Oracle VM Server for SPARC and `anet` resources in Oracle Solaris Kernel Zones. Starting with Oracle Solaris 11.2, you can use the `dladm show-vnic` command to display multiple MAC addresses that are associated with VNICs. See "Displaying VNICs With Multiple MAC Addresses" in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3* and *Oracle VM Server for SPARC 3.3 Administration Guide*.

- **Dropped packet accounting and reporting for datalinks** – The `dlstat` command is enhanced to support the reporting of input and output packet drops for datalinks. The `dlstat show-phys -o` command output includes four additiona fields that display the following information: number of input packet drops, number of bytes per input drops, number of output packet drops, and the number of bytes per output drops. For specific examples, see the `dlstat(1M)` man page.
- **Elastic Virtual Switch (EVS) feature** – EVS is an L2 technology that expands network virtualization capabilities by enabling you to manage virtual switches across multiple hosts. With the Oracle Solaris EVS feature, you can deploy virtual networks that span multiple hosts within either a multi-tenant cloud environment or datacenter. See Chapter 6, "Administering Elastic Virtual Switches" in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3*.
- **Displaying PV IPoIB datalinks for physical IB HCA in kernel zones** – You can display these types of datalinks by using the `dladm` command. See "Creating and Viewing Paravirtualized IPoIB Datalinks in Kernel Zones" in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3*.
- **Oracle Solaris CEE DCBX support** – In addition to IEEE, Oracle Solaris supports the Converged Enhanced Ethernet (CEE) data center bridging exchange (DCBX) feature This enhancement enables you to deploy Oracle Solaris Fibre Channel over Ethernet (FcoE) in those environments that have a diverse set of switches when using data center bridging (DCB). Oracle Solaris CEE DCBX supports priority-based flow control (PFC) and Application type-length-value (TLV). For more information, see "Setting the Mode of Operation for DCB" in *Managing Network Datalinks in Oracle Solaris 11.3*.
- **Private virtual local area networks** – Oracle Solaris includes support for private virtual local area networks (PVLANs), as defined in the RFC 5517 standard. You can use a PVLAN to divide a regular VLAN (primary) into sub-VLANs (secondary). For more information, see Chapter 4, "Configuring Private Virtual Local Area Networks" in *Managing Network Datalinks in Oracle Solaris 11.3*.
- **Probe-based datalink multipathing (DLMP)** – This feature enhancement for DLMP detects the loss of connectivity between DLMP aggregated links and configured targets. This type of failure detection addresses the limitations of the link-based failure detection mechanism, which can only detect failures caused by the loss of direct connection between the datalink and the first-hop switch. See "Configuring Probe-Based Failure Detection for DLMP Aggregation" in *Managing Network Datalinks in Oracle Solaris 11.3*.
- **Single root I/O virtualization (SR-IOV)** – Oracle Solaris includes the capability for managing network devices that support SR-IOV. See "Using Single Root I/O Virtualization With VNICs" in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3*.
- **Virtual eXtensible area networks (VXLANs)** – In addition to the VLAN support that was introduced in Oracle Solaris 11 11/11, VXLANs are now also supported. A VXLAN is an L2 and L3 technology that works by overlaying a datalink (L2) network on top of an IP (L3) network. VXLANs address the 4K limitation that is imposed when using VLANs. Typically,

VXLANs are used in a cloud infrastructure to isolate multiple virtual networks. You can manage VXLANs by using the EVS feature. See Chapter 3, “Configuring Virtual Networks by Using Virtual Extensible Local Area Networks” in *Managing Network Virtualization and Network Resources in Oracle Solaris 11.3*.

- **Layer 3 Virtual Router Redundancy Protocol (VRRP)** –Oracle Solaris 11 supports both L2 and L3 VRRP. The proprietary L3 VRRP feature provides high availability of IP addresses, such as those that are used for routers and load balancers. L3 VRRP removes the need to configure unique VRRP virtual MAC addresses for VRRP routers, thereby providing better support for VRRP over IPMP, InfiniBand interfaces, and zones. See Chapter 3, “Using Virtual Router Redundancy Protocol” in *Configuring an Oracle Solaris 11.3 System as a Router or a Load Balancer*.

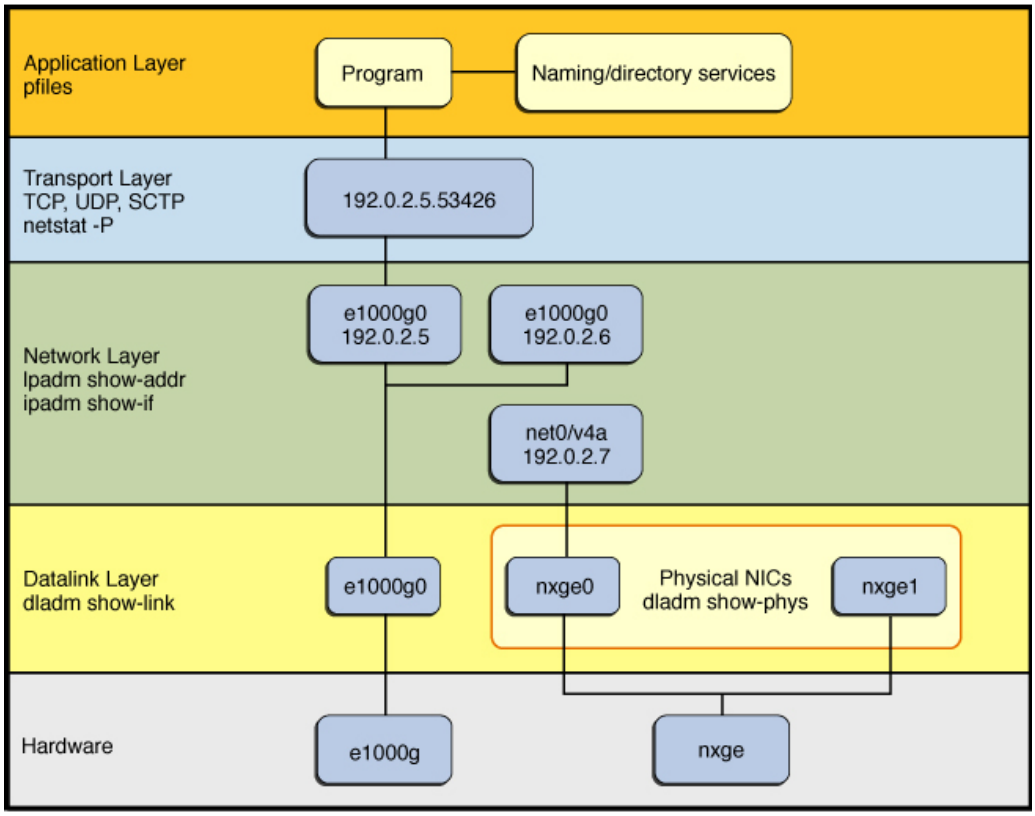
For information about Oracle VM, including Oracle VM Server for x86, Oracle VM Server for SPARC (previously called Sun Logical Domains, or LDoms), and Oracle VM Manager, see the documentation at `https://www.oracle.com/technetwork/documentation/vm-sparc-194287.html`.

Oracle also provides the Oracle Enterprise Manager Ops Center for managing some aspects of network virtualization, for example, the ability to create virtual private networks inside a virtual datacenter. For more information about Oracle Enterprise Manager Ops Center, go to `https://docs.oracle.com/cd/cloud-control-13.3/index.htm`.

Comparing the Oracle Solaris 10 Network Protocol Stack to the Oracle Solaris 11 Network Protocol Stack

In previous Oracle Solaris implementations of the network protocol stack, interfaces and links on the software layer were built on the devices in the hardware layer. More specifically, a hardware device instance in the hardware layer had a corresponding link on the datalink layer and a configured interface on the network layer. This one-to-one relationship amongst the network device, its datalink, and its IP interface is illustrated in the following figure.

FIGURE 1 Oracle Solaris 10 Network Protocol Stack With Network Devices, Links, and Interfaces Displayed

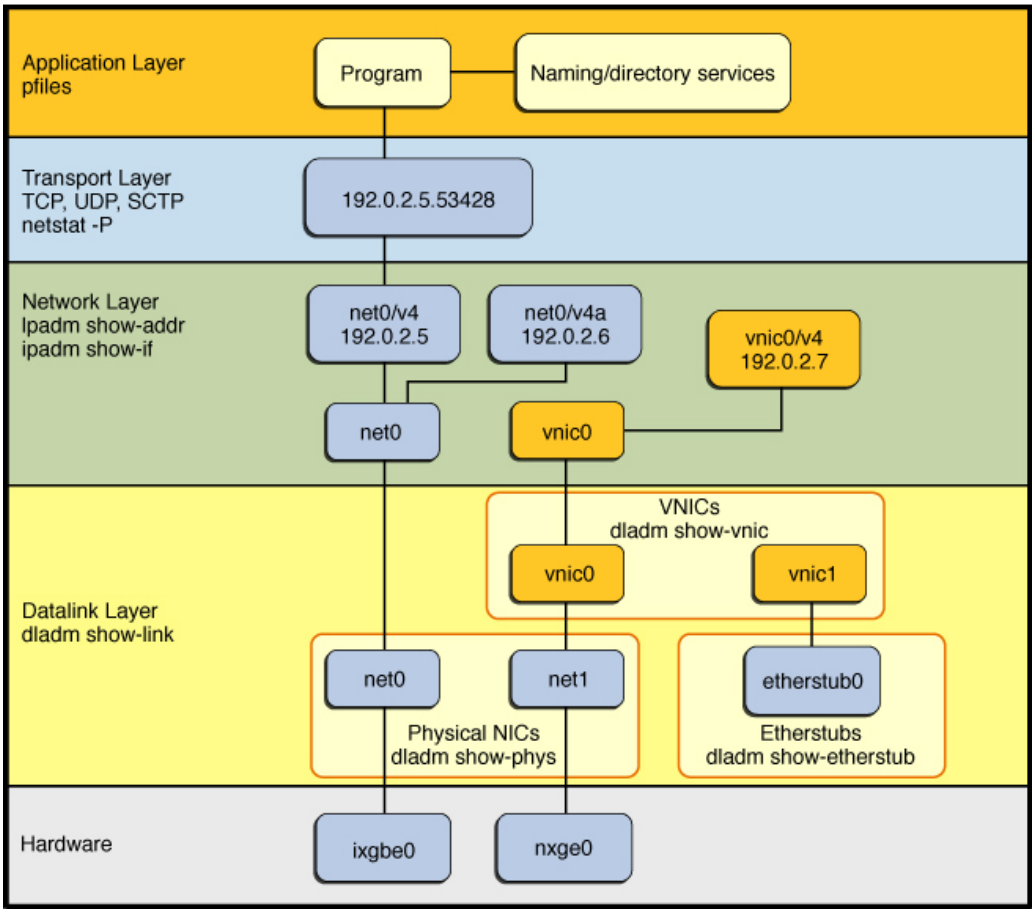


The Oracle Solaris 10 implementation has the following limitations:

- The one-to-one relationship that binds the device, the datalink, and the interface means that the network configuration is dependent on the hardware configuration and also the network topology. Thus, interfaces must be reconfigured if changes are implemented in the hardware layer, such as replacing the NIC or changing the network topology.
- There is limited support for virtual devices at the datalink layer. Only link aggregations are supported in Oracle Solaris 10.
- The `ifconfig` command manages logical interface names, where each logical interface corresponds to an IP address on the interface. It is not always obvious which managed features apply to the interface and which apply to individual addresses.

In Oracle Solaris 11, the one-to-one relationship between the hardware, datalink, and network layers remains, as shown in the following figure. However, the software layer is decoupled from the hardware layer. With this separation, network configuration on the software layer is no longer bound to the chipset or the network topology in the hardware layer.

FIGURE 2 Oracle Solaris 11 Network Protocol Stack With Devices, Links, and Interfaces Displayed



The changes that are implemented in Oracle Solaris 11 make network administration more flexible in the following ways:

- Network configuration is insulated from any changes that might occur in the hardware layer. Link and interface configurations are preserved even if the underlying hardware is removed. These same configurations can then be reapplied to any replacement NIC, provided that the two NICs are of the same type.
- The separation of the network configuration from the network hardware configuration also enables the use of customized link names in the datalink layer.
- With the abstraction of the datalink layer, multiple networking abstractions or configurations, such as VLANs, VNICs, physical devices, and link aggregations are unified into a common administrative entity, which is the datalink.

For more information about how networking features are administered within the Oracle Solaris network protocol stack, see "Network Administration Within the Oracle Solaris Network Protocol Stack" in *Strategies for Network Administration in Oracle Solaris 11.3*.

For information about using observability tools to display network configuration and monitor network traffic usage for features that are configured on each layer of the network stack, see Chapter 2, "Using Observability Tools to Monitor Network Traffic Usage" in *Troubleshooting Network Administration Issues in Oracle Solaris 11.3*.

Network Administration Command Changes

In Oracle Solaris 10 and previous releases, the `ifconfig` command is the customary tool that you use to configure network interfaces. However, the command does not implement persistent configuration. Over time, the `ifconfig` command has undergone enhancements to add further network administration capabilities. As a result, the command has become more complex and can sometimes be confusing to use.

Another issue with IP interface configuration and administration is the absence of simple tools to administer TCP/IP properties, also referred to as tunables. The `ndd` command has long been the prescribed customization tool for this purpose, but like the `ifconfig` command, the `ndd` command does not implement persistent configuration. Previously, persistent configuration could be simulated for a network scenario by editing the boot scripts. With the introduction of the service management facility (SMF), using these types of workarounds can be risky because of the complexities of managing the various SMF dependencies, particularly in light of upgrades to an Oracle Solaris installation.

Note the following key points about the network administration commands that you use in this release:

- The `ipadm` and `dladm` commands replace the `ifconfig` command for configuring network interfaces (datalinks and IP interfaces and addresses). Although the `ifconfig` command is still functional, it primarily exists for backward compatibility. Also, the previous method of adding information to the `/etc/hostname*` files is not supported in Oracle Solaris 11.

  You can perform most of the tasks that you previously performed with the `ifconfig` command by using either the `dladm` command (for datalink administration) or the `ipadm` command (for IP administration). Although many `ifconfig` command options have an `ipadm` equivalent, there is not an exact one-to-one mapping between the two commands. For comparable equivalents, see "Comparing the `ifconfig` Command to the `ipadm` Command" on page 92. See also the `ifconfig(5)` man page.
- The `ipadm` and `dladm` commands also replace the `ndd` command as a tool for customizing network parameters (*tunables*). Although the `ndd` command is still functional in Oracle Solaris 11, the `ipadm` and `dladm` commands are preferred.
- In Oracle Solaris 10, you configure drivers through driver-specific mechanisms, for example, the `ndd` command and the `driver.conf` file. However, in Oracle Solaris 11, you configure common driver features by setting `dladm` properties, as well as some driver-private features through driver-private properties.

Note - Some `ndd` options do not have equivalent `dladm` command options.

Comparing the `ifconfig` Command to the `ipadm` Command

Compared to the `ifconfig` command, the `ipadm` command provides the following advantages:

- Parameter interactions with interfaces and addresses that are clearly represented.
- Configuration commands that manage both the current system state, as well as keep a persistent record of that state synchronized for automatic use upon reboot.
- A committed, parsable output format with many subcommands that exist for easy use by shell scripts.
- User-defined IP address object names that provide a means for management scripts to easily reference individual addresses, including IP addresses that are defined through DHCP or IPv6 address autoconfiguration.

The following table compares selected `ifconfig` command options to the `ipadm` command equivalent. For an additional explanation of these changes, see the `ifconfig(5)` man page. For a comprehensive list of all of the available options, see `ipadm(1M)`.

TABLE 8 `ifconfig` and `ipadm` Command Comparison

Task Description	`ifconfig` Command	`ipadm` Command
List all interfaces and their addresses.	`ifconfig -a`	`ipadm`

Create or delete an IP interface.	`plumb`
	
	`unplumb`
		`ipadm create-ip`
		
		`ipadm delete-ip`

Create or delete a static IP address on an interface.	[*address*[/*prefix-length*] [*dest-address*]] [`addif` *address*[/*prefix-length*]] [`removeif` *address*[/*prefix-length*]][`netmask` *mask*] [`destination` *dest-address*].	`ipadm create-addr -a` *address* `ipadm delete-addr`
Create or delete a DHCP address on an interface.	{`auto-dhcp`|`dhcp`} [`wait` *seconds*] `start` | `release`	`ipadm create-addr -T dhcp` [`-w` *seconds*]. `ipadm delete-addr -r`
Extend a DHCP lease.	{`auto-dhcp` | `dhcp`} `extend`	`ipadm refresh-addr`
Obtain configuration parameters from DHCP without obtaining a lease.	{`auto-dhcp` | `dhcp`} `inform`	`ipadm refresh-addr -i`
Check if DHCP is in use on an interface.	{`auto-dhcp` | `dhcp`} `ping`	`ipadm show-addr` *interface*
Display DHCP status.	{`auto-dhcp` | `dhcp`} `status`	`netstat -D`

Create or delete an auto-configured IPv6 address on an existing interface	`inet6 plumb up`
	
	`unplumb`
		`ipadm create-addr -T addrconf`
		
		`ipadm delete-addr`

View/set address properties.	[`deprecated` | `-deprecated`] [`preferred` | `-preferred`] [`private` | `-private`] [`zone` `zonename` | `-zones` | `-all-zones`] [`xmit` | `-xmit`].	`ipadm show-addrprop`
		
		`ipadm set-addrprop`

Bring an address up.	`up`	`ipadm up-addr` Implicit in `create-addr` Required for explicit `down-addr`
Take an address down.	`down`	`ipadm down-addr`

Task Description	`ifconfig` Command	`ipadm` Command

View/set interface properties.	[`metric` *n*] [`mtu` *n*] [`nud` | `-nud`] [`arp` | `-arp`] [`usesrc` [*name* | `none`] [`router` | `router`].	`ipadm show-ifprop`
		
		`ipadm set-ifprop`

Create/delete an IPMP group.	`plumb ipmp group` [*name* | `""`]
	
	`unplumb`
		`ipadm create-ipmp`
		
		`ipadm delete-ipmp`

Add an interface to an IPMP group.	group [*name*]	`ipadm add-ipmp -i` *ifname*

Turn on/off standby flag.	`standby` | `-standby`	`ipadm set-ipfprop -p standby=on`
		
		`ipadm set-ipfprop -p standby=off`

Configure an IP tunnel link.	[`tdst`*tunnel-dest-addr*] [`tsrc` *tunnel-srcs-addr*] [`encaplimit` *n*| `-encaplimit`] [`thoplimit` *n*]	`dladm` *`-iptun` set of commands.
View/set the hardware address of a link.	[`ether` [*address*]].	`dladm show-linkprop -p mac-address` `dladm set-linkprop -p mac-address=`*addr*
View/set modules to be autopushed on a link.	[`modlist`] [`modinsert` *mod_name*`@pos`] [`modremove` *mod_name*`@pos`].	`dladm show-linkprop -p autopush` `dladm set-linkprop -p autopush=`*modlist*
Set subnet, netmask, broadcast domain.	`subnet` *subnet-address*] [`broadcast` *broadcast-address*]	`ipadm set-addrprop -p prefixlen=`*len*
Set IPsec policy for a tunnel link.	[`auth_algs` *authentication-algorithm*] [`encr_algs` *encryption-algorithm*] [`encr_auth_algs` *encryption- authentication-algorithm*].	`ipsecconf` See `ipsecconf(1M)`
Miscellaneous networking commands that have no `ipadm` command equivalent.	[`auth_revarp`] [`index` *if-index*] [`token` *address*/*prefix-length*] DHCP 'drop' option E	Not applicable.

`ifconfig` Replacement Commands

In Oracle Solaris 11, there is no single command that replaces the information that is displayed in the output of the `ifconfig -a` command. However, in most cases, using the `ipadm` command without any options provides very similar information. See the `ifconfig(5)` man page for further explanation.

To determine which command to use as a replacement for the `ifconfig` command, refer to the following information:

- Use the `ipadm` command without any options to display basic information about a system's interfaces:

```
# ipadm
NAME              CLASS/TYPE STATE        UNDER      ADDR
lo0               loopback   ok           --         --
   lo0/v4         static     ok           --         127.0.0.1/8
   lo0/v6         static     ok           --         ::1/128
net0              ip         ok           --         --
   net0/v4        dhcp       ok           --         203.0.113.65/24
   net0/v6        addrconf   ok           --         fe80::214:4fff:fefb:bbf0/10
```

- For MAC address information, use the `dladm` command with the following options:.

```
# dladm show-linkprop -p mac-address -o link,effective
```

- Display detailed IP interface state or property information as follows:

```
# ipadm show-if -o ifname,class,state,current,over
# ipadm show-ifprop -o ifname,property,proto,current
```

- Display detailed IP address state or property information as follows:

```
# ipadm show-addr -o addrobj,type,state,current,addr
# ipadm show-addrprop -o addrobj,property,current
```

- Display IP tunnel configuration details as follows:

```
# dladm show-iptun
```

- The following are situations in which you might still opt to use the `ifconfig` command:
  - To display the logical interface number for any given address or a link index number. The `ipadm` does not display this information and some applications still use these numbers.
  - As a diagnostic tool, the `ifconfig` command can provide additional information that you might not be able to obtain by using the `dladm` and `ipadm` commands.

The following two examples compare differences between the output of the `ifconfig` and the output of the `ipadm` command when used to obtain similar information about a system's datalink (`net0`).

```
# ifconfig net0
net0: flags=100001000942<BROADCAST,RUNNING,PROMISC,MULTICAST,IPv4,PHYSRUNNING> mtu
 1500 index 4
        inet 0.0.0.0 netmask 0
        ether 0:d0:b7:b9:a5:8c
# ifconfig net0 inet6
net0: flags=120002000940<RUNNING,PROMISC,MULTICAST,IPv6,PHYSRUNNING> mtu 1500 index 4
        inet6 ::/10

# ipadm show-if -o ifname,class,state,current,over net0
IFNAME     CLASS    STATE    CURRENT       OVER
net0       ip       down     bm46--------  --
sekon# ipadm show-ifprop -o ifname,property,proto,current net0
IFNAME      PROPERTY        PROTO CURRENT
net0        arp             ipv4  on
net0        forwarding      ipv4  off
net0        metric          ipv4  0
net0        mtu             ipv4  1500
net0        exchange_routes ipv4  on
net0        usesrc          ipv4  none
net0        forwarding      ipv6  off
net0        metric          ipv6  0
net0        mtu             ipv6  1500
net0        nud             ipv6  on
net0        exchange_routes ipv6  on
net0        usesrc          ipv6  none
net0        group           ip    --
net0        standby         ip    off
```

Comparing the `ndd` Command to the `ipadm` Command

Compared to the `ndd` command, the `ipadm` command provides the following advantages:

- Provides information about each TCP/IP property, such as a property's current and default value, as well as the range of possible values. Thus, debugging information is more easily obtained.

- Follows a consistent command syntax and is therefore easier to use.
- Persistent configuration of routing and transport layer tunables that is made possible by using an `ipadm` subcommand rather than the previously required uncommitted `ndd` commands that required the use of custom SMF scripts or `/etc/rc*.d` scripts.

The following table compares selected `ndd` command options to equivalent `ipadm` command options. See the `ipadm`(1M) man page for a more comprehensive list of command options.

TABLE 9 `ndd` Command Compared to the `ipadm` Command

`ndd` Command	`ipadm` Command
bash-3.2# **ndd -get /dev/ip ?** ip_def_ttl (read and write) ip6_def_hops (read and write) ip_forward_directed_broadcasts (read and write) ip_forwarding (read and write) ... ... bash-3.2# **ndd -get /dev/ip \ ip_def_ttl** 100 bash-3.2# **ndd -get /dev/ip \ ip6_def_hops** 255 bash-3.2# **ndd -get /dev/ tcp ?** tcp_cwnd_max (read and write) tcp_strong_iss (read and write) tcp_time_wait_interval (read and write) tcp_tstamp_always (read and write) tcp_tstamp_if_wscale (read and write) ... bash-3.2# **ndd -get /dev/tcp ecn** 1 bash-3.2# **ndd -get /dev/tcp sack**	bash-3.2# **ipadm show-prop ip** PROTO PROPERTY PERM CURRENT PERSISTENT DEFAULT POSSIBLE ipv4 forwarding rw off -- off on,off ipv4 ttl rw 255 -- 255 1-255 ipv6 forwarding rw off -- off on,off ipv6 hoplimit rw 255 -- 255 1-255 ... bash-3.2# **ipadm show-prop -p ttl,hoplimit ip** PROTO PROPERTY PERM CURRENT PERSISTENT DEFAULT POSSIBLE ipv4 ttl rw 255 -- 255 1-255 ipv6 hoplimit rw 255 -- 255 1-255 bash-3.2# **ipadm show-prop tcp** PROTO PROPERTY PERM CURRENT PERSISTENT DEFAULT POSSIBLE tcp ecn rw passive -- passive never,passive,active tcp extra_priv_ports rw 2049 2049,4045 2049,4045 1-65535 tcp largest_anon_port rw 65535 -- 65535 1024-65535 tcp recv_maxbuf rw 128000 -- 128000 2048-1073741824 tcp sack rw active -- active never,passive,active tcp send_maxbuf rw 49152 -- 49152 4096-1073741824 tcp smallest_anon_port rw 32768 -- 32768 1024-65535 tcp smallest_nonpriv_port rw 1024 -- 1024 1024-32768 ... bash-3.2# **ipadm show-prop -p ecn,sack tcp** PROTO PROPERTY PERM CURRENT PERSISTENT DEFAULT POSSIBLE tcp ecn rw passive -- passive never,passive,active tcp sack rw active -- active never,passive,active

`ndd` Command	`ipadm` Command
2	

Comparing the `ndd` Command and `driver.conf` Configuration to the `dladm` Command

In Oracle Solaris 10, you use the `ndd` command to customize network parameters (tunables) and some driver-specific properties. Although the `ndd` command is still functional in Oracle Solaris 11, the `dladm` command is the preferred command for managing these properties.

The `driver.conf` file is also used in Oracle Solaris 10 to configure some driver-specific properties. In Oracle Solaris 11, you can configure some common driver features by setting `dladm` properties, as well as certain driver-private features through driver-private properties.

The following three classes of tunables are configurable:

- **Common generic properties** – The majority of these properties have a straightforward mapping to a `dladm` command equivalent.

  While `ndd` command parameters are queried and set with the `-get` and `-set` subcommands, `dladm` properties are queried and set with the `show-linkprop` and `set-linkprop` subcommands. You can also reset `dladm` properties by using the `reset-linkprop` subcommand. The following examples illustrate some of the differences between these two commands.

  In the following example, the `ndd` command is used with the `-get` subcommand to retrieve the link speed of the datalink `net0`:

  ```
  # ndd -get /dev/net/net0 link_speed
  ```

  The following example shows how you would use the `dladm` command to retrieve the information from the speed property:

  ```
  # dladm show-linkprop -p speed net0
  LINK     PROPERTY        PERM VALUE        EFFECTIVE    DEFAULT   POSSIBLE
  net0     speed           r-   0            0            0         --
  ```

  Another example is how the automatic negotiation of the link speed and duplex setting is enabled. In the following example, the `ndd` command is used to set the `adv_autoneg_cap` parameter:

  ```
  # mdd -set /dev/net/net0 adv_autoneg_cap 1
  ```

  Note that the `ndd` command does not configure settings that persist between reboots.

The following example shows how to enable the automatic negotiation of the link speed and duplex setting by using the `dladm` command to set the `adv_autoneg_cap` parameter:

```
# dladm set-linkprop -p adv_autoneg_cap=1
```

When you use the `dladm` command, the changes take place immediately and are persistent between system reboots.

- **Capability related tunables** – Many of these properties have an equivalent `dladm` command option in Oracle Solaris 11. The list of properties is extensive. See the "Ethernet Link Properties" section of the `dladm`(1M) man page.

  You can display these properties by using the `dladm` command without any options, or you can use the `dladm show-ether` command. If you do not specify any options with the `dladm show-ether` command, only the current Ethernet property values for the datalink are displayed. To obtain information beyond what is provided by default, use the `-x` option, as shown in the following example:

  ```
  # dladm show-ether -x net1
  LINK     PTYPE       STATE    AUTO  SPEED-DUPLEX             PAUSE
  net1     current     up       yes   1G-f                     both
  --       capable     --       yes   1G-fh,100M-fh,10M-fh     both
  --       adv         --       yes   100M-fh,10M-fh           both
  --       peeradv     --       yes   100M-f,10M-f             both
  ```

  With the `-x` option, the command also displays the built-in capabilities of the specified link, as well as the capabilities that are currently advertised between the host and the link partner.

- **Driver-specific properties** – In Oracle Solaris 11, how you configure properties that were previously stored in the `driver.conf` file depends on the specific driver. The main property that was previously configured in this file is the maximum transmission unit (MTU) property. You manage this property by using the `dladm` command. See "Setting the MTU Property" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

For more information about the various properties that you can customize by using the `dladm` command, see "Obtaining Status Information for Datalink Properties" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

For information about configuring other private driver properties, refer to the manufacturer's documentation for that driver.

Configuring the Network in Oracle Solaris 11

Refer to the following information when transitioning from the network configuration model that is used in Oracle Solaris 10 the model that is used in Oracle Solaris 11.

How the Network Is Configured During an Installation

During an installation, the network is configured as follows:

- For a GUI installation, the system-generated `Automatic` profile is activated on the system and the network is automatically configured, based on the current network conditions.
- For a text installation, you must choose one of the following: `Automatic`, `Manual`, or `None`.
  - If you choose `Automatic`, the `Automatic` profile is activated on the system and the network is automatically configured upon reboot. See "Managing Network Configuration in Reactive Mode" on page 106.
  - If you choose `Manual`, the system's only fixed profile (`DefaultFixed`) is activated, and you are presented with a series of installation screens that enable you to manually configure network settings.
  - If you choose `None`, the `DefaultFixed` is activated on the system, but you do not provide network parameters during the installation. Thus, after a reboot, no network interface is plumbed or configured. Only the loopback IPv4 and IPv6 interfaces (`lo0`) are activated. You can create persistent network configuration after the installation. See "Network Administration Task Comparison" on page 101.
- For an installation with AI, the network is configured according to the profile that you set up before the installation. If you did not specify any network settings prior to installing Oracle Solaris, the interactive `sysconfig` tool runs during the installation, enabling you to set network parameters for the system at that time. See *Installing Oracle Solaris 11.3 Systems*.

  The `svc:/network/install:default` SMF service has two property group types: `ipv4_interface` and `ipv6_interface` that enable you to configure multiple network interfaces during an installation with AI. You can create SC profiles that contain property groups with the type `ipv4_interface` and, or `ipv6_interface`. The existing `install_ipv4_interface` and `install_ipv6_interface` property groups for this service continue to be supported in this release. See *Installing Oracle Solaris 11.3 Systems*.

Because the commands that you use to manage network configuration depend on which network mode your system defaults to after an installation, make sure you know which

network profile is currently active on your system by using the `netadm list` command prior to configuring the network. See "Enabling and Disabling Profiles" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Network Administration Task Comparison

The following table compares Oracle Solaris 10 network administration tasks to Oracle Solaris 11 network administration tasks. For more information, see the `dladm`(1M) and `ipadm`(1M) man pages.

TABLE 10 Comparing Oracle Solaris 10 Network Administration With Oracle Solaris 11 Network Administration

Task Information	Oracle Solaris 10 Command or Method	Oracle Solaris 11 Command or Method
Datalink configuration	`dladm`	`dladm`
IP interface and IP address configuration	`ifconfig` Edit `/etc/hostname*`	`ipadm`
DHCP server configuration	SMF service: `svc:/network/dhcp-server:` and default DHCP management commands: `dhcpmgr`, `dhtadm`, and `pntadm`	(Sun Legacy) SMF service: `svc:/network/dhcp-server:` SMF service and default DHCP management commands: `dhcpmgr`, `dhtadm`, and `pntadm` (ISC) SMF services: `svc:/network/dhcp/server:ipv4` `svc:/network/dhcp/server:ipv6` `svc:/network/dhcp/relay:ipv4` `svc:/network/dhcp/relay:ipv6` Configuration files: `/etc/inet/dhcpd4.conf` `/etc/inet/dhcpd6.conf`
DHCP client configuration	`ifconfig` Edit `/etc/dhcp*` and `/etc/default/dhcpagent`	`ipadm` Edit `/etc/default/dhcpagent`
Name services switch configuration	SMF service: `svc:/system/name-service/switch:default` and `/etc/nsswitch.conf`	SMF service: `svc:/system/name-service/switch:default`. Modify with `svccfg`; view with `svcprop -p config svc:/system/name-service/switch:default`
System host name configuration	Edit `/etc/nodename`	`hostname`
TCP/IP host name configuration	Edit `/etc/inet/hosts` .	Edit `/etc/inet/hosts`

Task Information	Oracle Solaris 10 Command or Method	Oracle Solaris 11 Command or Method
Network parameter administration (tunables)	`ndd`	`ipadm`
Wireless network configuration	`wificonfig`	`dladm`

Administering Datalink Configuration

When you perform a fresh installation, all datalinks are automatically assigned generic names by using the `net0`, `net1`, and `net`*N* naming convention, depending on the total number of network devices on a system. After the installation, you can assign different datalink names. See Chapter 2, "Administering Datalink Configuration in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Note - During an upgrade, link names that were used previously are retained.

Display information about the datalinks on a system as follows:

```
# dladm show-phys
LINK              MEDIA               STATE      SPEED  DUPLEX    DEVICE
net2              Ethernet            up         10000  full      hxge0
net3              Ethernet            up         10000  full      hxge1
net4              Ethernet            up         10     full      usbecm0
net0              Ethernet            up         1000   full      igb0
net1              Ethernet            up         1000   full      igb1
net9              Ethernet            unknown    0      half      e1000g0
net5              Ethernet            unknown    0      half      e1000g1
net10             Ethernet            unknown    0      half      e1000g2
net11             Ethernet            unknown    0      half      e1000g3
```

Based on the criteria, Ethernet devices on a lower motherboard or IO board, host bridge, PCIe root complex, bus, device, and function are ranked ahead of the other devices. You can display the correspondence between link names, devices, and locations as follows:

```
# dladm show-phys -L
LINK         DEVICE       LOCATION
net0         e1000g0      MB
net1         e1000g1      MB
net2         e1000g2      MB
net3         e1000g3      MB
net4         ibp0         MB/RISER0/PCIE0/PORT1
net5         ibp1         MB/RISER0/PCIE0/PORT2
net6         eoib2        MB/RISER0/PCIE0/PORT1/cloud-nm2gw-2/1A-ETH-2
net7         eoib4        MB/RISER0/PCIE0/PORT2/cloud-nm2gw-2/1A-ETH-2
```

In Oracle Solaris 10, you can use the `/etc/path_to_inst` file to store information about physical and virtual network devices. In Oracle Solaris 11, this file does not contain link names for physical network interfaces. To display this information, use the `dladm show-phys` command, as shown in the previous example.

See Chapter 2, "Administering Datalink Configuration in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Configuring IP Interfaces and Addresses

You use the `ipadm` command to configure IP interfaces and addresses in Oracle Solaris 11. For example, a static IPv4 interface is configured as follows:

```
# ipadm create-ip net0
# ipadm create-addr -T static -a local=203.0.113.7/24 net0
net0/v4
```

You can use the `-T` option to specify three address types: `static`, `dhcp`, and `addrconf` (for auto-configured IPv6 addresses). In the previous example, the system is configured with a static IPv4 address. You can use the same syntax to specify a static IPv6 address. However, static IPv6 addresses require that a link-local IPv6 address be configured prior to creating any static IPv6 addresses. This configuration is accomplished by creating an IPv6 `addrconf` address before creating the static IPv6 address:

```
# ipadm create-ip net0
# ipadm create-addr -T addrconf net0
net0/v6
# ipadm create-addr -T static -a local=ec0:a:99:18:209:3dff:fe00:4b8c/64 net0
net0/v6a
```

Configure an interface with DHCP as follows:

```
# ipadm create-ip net0
# ipadm create-addr -T dhcp net0
net0/v6a
```

Use the `addrconf` argument with the `-T` option to specify an automatically generated IPv6 address:

```
# ipadm create-ip net0
# ipadm create-addr -T addrconf net0
net0/v6
```

If you wanted to change the IP address that was provided for the `net0` interface in the previous example, you would need to first remove the interface and then re-add it, as shown in the following example:

```
# ipadm delete-addr net0/v4
# ipadm create-addr -T static -a local=203.0.113.7/24 net0
net0/v4
```

See Chapter 3, "Configuring and Administering IP Interfaces and Addresses in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3* and `ipadm`(1M).

Configuring Persistent Routes

Because the `/etc/defaultrouter` file is deprecated in Oracle Solaris 11, you can no longer manage routes (default or otherwise) by using this file. Using the `route` command is the only way that you can manually add a route to a system. To make the changes persist across reboots, use the `-p` option with the `route` command.

```
# route -p add default ip-address
```

For example, you would add a route to network `203.0.113.0`, which has its gateway as the border router, as follows:

```
# route -p add -net 203.0.113.0/24 -gateway 203.0.113.150
add net 203.0.113.0: gateway 203.0.113.150
```

View routes that were created by the using the previous command as follows:

```
# route -p show
```

Also, note that after an installation, you can no longer determine a system's default route by checking the `/etc/defaultrouter` file. To display the currently active routes on a system, use the `netstat` command with the following options:

```
# netstat -rn
```

See the `netstat`(1M) and `route`(1M) man pages.

For instructions, see "Creating Persistent (Static) Routes" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Configuring Naming and Directory Services

In this release, the SMF repository is the primary repository for all naming services configuration. The previous behavior of modifying a particular file to manage naming services

configuration no longer applies. For information about the naming services that have migrated to SMF, see Table 12, “SMF Service to Legacy File Mapping,” on page 113.

During an installation, the system undergoes a one-time upgrade to convert any existing `/etc` network configuration files to their respective `ipadm` and `dladm` configurations. If necessary, you can use the `nscfg` command to import or export legacy name service configuration files into or out of the SMF repository. When a valid SMF configuration and corresponding Fault Management Resource Identifier (FMRI) is supplied, the `nscfg` command regenerates legacy naming service configuration files, for example, `nsswitch.conf`, `resolv.conf`, `nscd.conf`, into their legacy locations. See “Importing Naming Services Configuration” in *Configuring and Managing Network Components in Oracle Solaris 11.3* and `nscfg`(1M).

Note - The persistent configuration of naming services through SMF applies to the fixed network configuration mode *only* and only when the `DefaultFixed` profile is active on the system. If you are using the reactive mode and the `Automatic` or another reactive profile is active on the system, you configure naming services in a `Location` profile by using the `netcfg` command and not through SMF. See “Creating Locations” in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

The following example shows how you would configure the Domain Name Service (DNS) by using the `svccfg` command. After you set the various properties, you must enable and refresh the SMF service.

```
# svccfg -s dns/client setprop config/nameserver=net_address: 192.0.2.1
# svccfg -s dns/client setprop config/domain = astring: "foohost.org"
# svccfg -s name-service/switch setprop config/host = astring: "files dns"
# svcadm refresh name-service/switch
# svcadm refresh dns/client
```

You can also configure naming and directory SMF service properties interactively. See “Configuring a DNS Client” in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

See Chapter 4, “Administering Naming and Directory Services on an Oracle Solaris Client” in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

Administering DHCP

Note the following information about DHCP administration in this release:

- The ISC DHCP server software is available for installation in this release. You can add the server package to your system as follows:

```
# pkg install pkg:/service/network/dhcp/isc-dhcp
```

For more information about administering ISC DHCP, including configuring the ISC DHCP server administering the ISC DHCP service, see Chapter 2, “Administering the ISC DHCP Service” in *Working With DHCP in Oracle Solaris 11.3*.

- The legacy Sun DHCP server software is still part of the Oracle Solaris release, but the feature has been marked as obsolete. See “Legacy Sun DHCP Server” in *Working With DHCP in Oracle Solaris 11.3*.
- The term DHCP client refers to a software entity. The DHCP client is a daemon (`dhcpagent`) that runs on systems that are configured to request their network configuration from the DHCP service. Both the legacy Sun DHCP server and the ISC DHCP server work with the DHCP client. See Chapter 3, “Configuring and Administering the DHCP Client” in *Working With DHCP in Oracle Solaris 11.3* for details.

Setting a System's Host Name

The primary interface's TCP/IP host name is a distinct entity from the system host name that you set with the `hostname` command. Although not required by Oracle Solaris, the same name is normally used for both. Some network applications depend on this convention.

Permanently set a system's host name as follows:

```
# hostname name-of-host
```

Initially, the `hostname` value is stored in `config/nodename`, but this value is overridden if the system is configured by DHCP, in which case, DHCP provides the `hostname` value. If you use the `hostname` command, then the `hostname` is the value that is specified in the `config/nodename` file. If you set a system's identity by using the `hostname` command, this setting cannot be overridden by DHCP until you execute the `hostname` command with the `-D` option. The corresponding SMF properties and the associated SMF service are also automatically updated when you use the `hostname` command. See the `hostname(1)` man page.

Managing Network Configuration in Reactive Mode

When you are using the reactive network configuration mode, the system handles network connectivity and network configuration based on the current network conditions. The reactive mode uses different profiles to specify the various parameters that define a system's network

configuration. These profiles are automatically enabled on the system in response to changes in network conditions. Or, you can manually enable profiles on a system, as needed.

Reactive network configuration is most suitable for notebook PCs and in situations where cables are regularly plugged or unplugged, cards are added or removed, etc. Assuming your site has a DHCP server that can provide IP addresses and name service information, reactive network configuration provides out-of-box functionality for automatic network configuration of a system that does not require manual configuration. For a detailed overview of profile-based network configuration, see "About Profile-Based Network Configuration" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

For the reactive network configuration mode, you use the `netcfg` command to configure system-specific network configuration (datalinks and IP interfaces and addresses), as well as system-wide network configuration, for example, naming services. There is a second command, `netadm`, that you use to administering profiles on a system. These commands create network configuration that is applied to both the active and non-active profiles on the system.

For related tasks, see Chapter 6, "Administering Profile-Based Network Configuration in Oracle Solaris" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

You can also manage network configuration from the desktop by using the network administration GUI (formerly NWAM). This tool is similar to using the `netcfg` and `netadm` commands for managing reactive network configuration. In situations where network conditions change, you will want to activate the system-defined `Automatic` NCP or a user-defined reactive NCP. See "Administering Network Configuration From the Desktop" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

♦ ♦ ♦ CHAPTER 8

Managing System Configuration

This chapter provides information about the system configuration features and tools that are supported in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

System Configuration Changes

The following is a summary of Oracle Solaris 11 system configuration changes:

- `/etc/default/init` **file is read-only** – Locale and time zone configuration have migrated to the Service Management Facility (SMF). All changes to environment variables should be managed through the new `svc:/system/environment:init` SMF service. See "Internationalization and Localization Changes" on page 132.
- `/etc/dfs/dfstab` **configuration** – Publishing and unpublishing a file system share is done with the `zfs` command. See Chapter 5, "Managing File Systems".
- `/etc/hostname.`<if>, `/etc/dhcp.`<if>, and `/etc/hostname.ip*.tun*` **configuration** – These files are removed in Oracle Solaris 11. Therefore, you can no longer manage

persistent network configuration by editing these files. Instead, use the `dladm` and `ipadm` commands to manage network configuration. See "Configuring the Network in Oracle Solaris 11" on page 100.

- `/etc/system.d` **implementation** – This directory provides an easier way to package Oracle Solaris kernel configuration than the traditional method of editing the `/etc/system` file. Because you can use IPS to deliver fragments (one line or many) into files within the `/etc/system.d/` directory, rather than editing the `/etc/system` file through first boot SMF services or other scripting, you can deliver any Oracle Solaris kernel customizations much more easily. See `system(4)`.

Note - The `/etc/system` file remains fully supported in this release. However, for third-party software, using files within the `/etc/system.d/` directory rather than editing the `/etc/system` file is encouraged.

Also, as part of this change, the `cryptoadm` and `dtrace` commands have been updated to write to files within the `/etc/system.d/` directory rather than the `/etc/system` file as in previous releases. See `cryptoadm(1M)` and `dtrace(1M)`.

- **Mapping a host name to a system's primary interface** – A system's host name is mapped to the primary interface at installation time. The `system/identity:node` SMF service includes a property that enables an administrator to disable the feature.
- **Power management configuration** – Power management is no longer configured by editing the `/etc/power.conf` file and by using the `pmconfig` command. Instead, the `poweradm` command is used. See "Power Management Configuration Changes" on page 117.
- **Setting a system's host name** – Use the `hostname` command to permanently set a system's host name. Initially, the `hostname` value is stored in `config/nodename`, but this value is overridden if the system is configured by DHCP, in which case, DHCP provides the `hostname` value. If the `hostname` command is used, then the `hostname` value is whatever is specified in `config/nodename`. If you set a system's identity by using the `hostname` command, this setting cannot be overridden by DHCP until you execute the `hostname` command with the `-D` option. The corresponding SMF properties and the associated SMF service are also automatically updated when you use the `hostname` command. See `hostname(1)`.
- **System console and terminal services configuration** – The `sac` command and the Service Access Facility (SAF) program are no longer supported. The system console and locally connected terminal devices are represented as instances of the `console-login` SMF service. See "System Console and Terminal Services Changes" on page 117.
- **System crash dumps** – This release supports the *deferred dump* process for managing system crash dumps. During a reboot, crash dump files are extracted from memory to

the file system that is defined in the dump configuration. Once these files are written, the system automatically reboots to normal multiuser configuration. Deferred dumps enable systems to return to a running state more quickly after a system panic. Using the deferred dump process is beneficial for systems that ship without a local disk. For more information, see Chapter 1, "Troubleshooting System Crashes" in *Troubleshooting System Administration Issues in Oracle Solaris 11.3*.

- **System logging services** – The `rsyslog` daemon is a reliable and extended `syslog` daemon with a modular design implementation that supports several features, for example, filtering, TCP, encryption, high-precision timestamps, as well as output control.

  Display the status of the `system-log` services as follows:

  ```
  # svcs system-log
  ```

  Note that the `rsyslog` package is not installed by default. Run the following command to install the package:

  ```
  # pkg install rsyslog
  ```

  Note - The `syslog` SMF service, `svc:/system/system-log:default`, continues to be the default logging service in Oracle Solaris 11.

- **System recovery and cloning** – The Oracle Unified Archives feature provides support for boot environments (BEs), IPS, and the various virtualization technologies that are available in Oracle Solaris 11. The Unified Archives feature is more robust and flexible than the flash archive installation method that is used in Oracle Solaris 10. See "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129.
- **Time zone configuration** – In Oracle Solaris 10, the time zone is configured by editing the `/etc/TIMEZONE` (`/etc/default/init`) file. In Oracle Solaris 11, the `svc:/system/timezone:default` SMF service enables you set a system's time zone. See "Locale, Timezone, and Console Keymap Configuration Changes" on page 134.

Oracle Solaris 10 and Oracle Solaris 11 System Configuration Feature Comparison

The following table compares Oracle Solaris 10 and Oracle Solaris 11 system configuration features.

TABLE 11 Oracle Solaris 10 and Oracle Solaris 11 System Configuration Comparison

System Configuration Feature, Tool, or Function	Oracle Solaris 10	Oracle Solaris 11
System configuration (network, and naming service configuration)	Configured in various files within the `/etc` directory	Configured through properties of the appropriate SMF service. See "Configuring Naming and Directory Services" on page 104
System console service (serial port monitor) configuration	`getty`, `pmadm`, `ttyadm`, `ttymon`	Configured through properties of the appropriate SMF service See "System Console and Terminal Services Changes" on page 117
System configuration (host name)	Edit `/etc/nodename`	Use the `hostname` command. See `hostname(1)`
System configuration (Oracle Solaris kernel customizations)	Edit `/etc/system`	Edit `/etc/system` Add configuration to files within the `/etc/system.d` directory
System logging	`syslog`	`syslog` (default) and `rsyslog` See "Naming and Directory Services Migration to SMF" on page 113
Power management	Edit `/etc/power.conf` or use the `pmconfig` command	`poweradm` See "Power Management Configuration Changes" on page 117
System reconfiguration	By using the `sysidtool`. `sys-unconfig`, `sysidconfig`, and `sysidcfg` commands	`sysconfig` or the SCI tool See "System Configuration Tools Changes" on page 118
System registration	Auto Registration feature Starting with Oracle Solaris 10 1/13: Oracle Configuration Manager	Oracle Configuration Manager See "System Registration and Customer Support Changes" on page 119
System recovery and cloning	Oracle Solaris Flash Archive features	Oracle Solaris Unified Archives "System Recovery and Cloning With the Oracle Solaris Unified Archives Feature" on page 129
Printer configuration and administration	LP print commands, Solaris Print Manager	CUPS command-line, CUPS Print Manager, and CUPS web browser interface See "Printer Configuration and Management Changes" on page 130
Locale and time zone configuration	Edit `/etc/default/init`	Configured through properties of the appropriate SMF service

System Configuration Feature, Tool, or Function	Oracle Solaris 10	Oracle Solaris 11
		See "Locale, Timezone, and Console Keymap Configuration Changes" on page 134

Service Management Facility Changes

The following information pertains to Service Management Facility (SMF) changes in Oracle Solaris 11. For information about features that are new in this release, see "New Features in This Release" in *Managing System Services in Oracle Solaris 11.3*.

Naming and Directory Services Migration to SMF

Naming and directory services configuration are managed through SMF in this release. The following table describes the various configuration files that have migrated to SMF control. For information about importing legacy naming services configuration to SMF after an installation, see "Importing Naming Services Configuration" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.

TABLE 12 SMF Service to Legacy File Mapping

SMF Service	Files	Description
`svc:/system/name-service/switch:default`	`/etc/nsswitch.conf`	Naming service switch configuration (used by the `nscd` command)
`svc:/system/name-service/cache:default`	`/etc/nscd.conf`	Naming service cache (`nscd`)
`svc:/system/name-service/upgrade:default`	Not applicable	Naming legacy file to SMF upgrade service
`svc:/network/dns/client:default`	`/etc/resolv.conf`	DNS naming service
`svc:/network/dns/multicast:default` .	Not applicable	Multicast DNS (`mdnsd`)
`svc:/network/ldap/client:default`	`/var/ldap/*`	LDAP client naming service (`ldap_cachemgr` and related files)
`svc:/network/ldap/server:openldap_24`	`/etc/openldap/slapd.conf`	Stand-alone OpenLDAP configuration (`slapd`)
`svc:/network/nis/domain:default`	`/etc/defaultdomain /var/yp/binding/$DOMAIN/*`	Shared NIS domain configuration (used by all NIS services). Also

SMF Service	Files	Description
		historical shared use by LDAP naming services **Note -** Must be enabled when using `nis/client` or `ldap/client`.
`svc:/network/nis/client:default`	Not applicable	NIS client naming service (`ypbind` and related files)
`svc:/network/nis/server:default`	Not applicable	NIS server naming service (`ypserv`)
`svc:/network/nis/passwd:default`	Not applicable	NIS server `passwd` service (`rpc.yppasswdd`)
`svc:/network/nis/xfr:default`	Not applicable	NIS server transfer naming service (`ypxfrd`)
`svc:/network/nis/update:default`	Not applicable	NIS server update naming service (`rpc.ypupdated`)

SMF Administrative Changes

Information for recording the source of properties, property groups, instances, and services has been added to the SMF repository. This information enables you to determine which settings are administrative customizations and those that are delivered by a service manifest or profile. The different settings, by administrator, profile, or manifest, are captured in *layers*. See "Repository Layers" in *Managing System Services in Oracle Solaris 11.3*.

You can use the `svcprop` and `svccfg listprop` commands to display the layer that is the source of a property value. If you use the `-l` option with either command, you must include an argument to specify the layer for which you want information. If you specify the `-l` option with the `all` argument, the output indicates whether a specific property value was set in the service manifest, a profile, or by an administrator. if you specify the `admin` or some other argument with the `-l`option, just the changes that were made in that layer are shown. For more information, see "Showing the Layer Where a Value Is Set" in *Managing System Services in Oracle Solaris 11.3*.

If you do not specify the `-l` option with the `svcprop` and `svccfg listprop` commands, the values that are currently in use are displayed. These values might come from a manifest, a profile, or an administrative change.

You can use the `svccfg listcust` command to list customizations *only*. Customizations are values that are set in the administrative layer by using the `svccfg setprop` command. See "Showing Configuration Customizations" in *Managing System Services in Oracle Solaris 11.3*.

Services and instances that are delivered in standard locations, such as `/lib/svc/manifest` and `/etc/svc/profile`, are imported into the SMF database by the `manifest-import` SMF

service. To completely remove these services from the system, you must uninstall the package that delivers the supporting files. This change triggers the removal of the service or instance from the system. If the delivering files are not managed by a package, then removing the file and restarting the `manifest-import` service removes the services or instances that are delivered from the system entirely.

If you cannot remove the files or you do not want the service or instance to run on the system, and disabling the service or instance is not an option, you can use the `svccfg delete` command, which is considered an administrative customization to the way the system is currently installed when the delivering files are still present in standard locations.

Note - The `svccfg delete` command does not delete the service. The command only hides the service from other SMF consumers.

To remove any administrative customizations, including customizations that you made with the `svccfg delete` command, and return to the configuration that is specified by the manifests and profiles, use the `svccfg delcust` command *with care*. This command removes administrative customizations from the service, thereby returning the repository to the on-disk configuration for that service. You can also specify an argument with the `svccfg delcust` command to just delete certain customizations. In this case, the service would not be restored to its on-disk configuration. See the `svccfg`(1M) man page for more details.

SMF Manifest Creation Tool

You can use the `svcbundle` command to generate SMF manifests. You can also use the command to generate profiles by specifying the `bundle-type` option. The generated bundle is defined by multiple `-s name=value` options. Some examples of name arguments include `bundle-type`, `instance-name`, `service-name`, and `start-method`. To generate a manifest, you must specify a `service-name` and `start-method`. The `svcbundle` command uses default values for some service characteristics. You can edit the generated manifest. Follow the DTD that is specified at the top of the manifest.

For detailed instructions, see *Developing System Services in Oracle Solaris 11.3* and the `svcbundle`(1M) man page.

System Process Management Changes

The following features are new or changed in this release.

Named Thread Support

This Oracle Solaris 11 release includes thread naming capabilities that enable the naming of user processes and kernel threads. You can display thread names by using the `ps`, `prstat`, and `pstack` commands. In addition, new built-in variables, `uthreadname` and `kthreadname`, have been added to DTrace to enable you to access the names of user and kernel threads.

You can set and read process thread names by using the `pthread_setname_np`(3C)/`pthread_attr_setname_np`(3C) and `pthread_getname_np`(3C)/`pthread_attr_getname_np`(3C) functions. See the appropriate man pages for more information.

The following example shows how to display thread names by using the `ps` command with the `-L` option:

```
$ ps -L
PID   LWP   LNAME       TTY         LTIME  CMD
2644    1               pts/32      0:00   bash
14320   1   foomoe      pts/32      0:00   a.out
14320   2   foocurly    pts/32      0:00   a.out
14320   3   foolarry    pts/32      0:00   a.out
14320   4   fooshemp    pts/32      0:00   a.out
14321   1               pts/32      0:00   ps
```

See also the *Multithreaded Programming Guide*.

System Process Summary Information

Both Oracle Solaris 10 and Oracle Solaris 11 include some system processes that perform a specific task, but typically do not require any administration, such as those that are listed in the following table.

TABLE 13 System Processes That Require No Administration

System Process	Description
`fsflush`	System daemon that flushes pages to disk
`init`	Initial system process that starts and restarts other processes and SMF components
`intrd`	System process that monitors and balances system load due to interrupts
`kmem_task`	System process that monitors memory cache sizes
`pageout`	System process that controls memory paging to disk
`sched`	System process that is responsible for OS scheduling and process swapping

System Process	Description
`vm_tasks`	System process with one thread per processor that balances and distributes virtual memory related workloads across CPUs for better performance.
`zpool-`*pool-name*	System process for each ZFS storage pool containing the I/O `taskq` threads for the associated pool

System Console and Terminal Services Changes

The `sac` command and the Service Access Facility (SAF) program are no longer supported. The system console and locally connected terminal devices are represented as instances of the `console-login` SMF service. Each instance can have specific overrides to the settings that are inherited from the service.

Note - The `sac` and `getty` modes of the `ttymon` command are no longer supported. However, the `ttymon express` mode is still supported.

If you want to offer login services on auxiliary terminals, use one of the following services:

- `svc:/system/console-login:terma`
- `svc:/system/console-login:termb`

The `ttymon` program is used to offer login services for these terminals. Each terminal uses a separate instance of the `ttymon` program. Command-line arguments that are passed by the service to the `ttymon` program govern the terminal's behavior. See Chapter 5, “Managing the System Console, Terminal Devices, and Power Services” in *Managing System Information, Processes, and Performance in Oracle Solaris 11.3*.

Power Management Configuration Changes

In Oracle Solaris 10, you administer power management by configuring the `/etc/power.conf` file and by using the `pmconfig` command. In Oracle Solaris 11, the `poweradm` command replaces the `pmconfig` command. Power administration in Oracle Solaris 11 includes a small number of controls that manage platform and implementation details. The `poweradm` command enables you to simplify power administration by manipulating a small number of controls. See `poweradm`(1M).

Review the following potential power management transition issues:

- By default, suspend is not enabled on any system. To enable suspend and inspect this setting on systems that support this feature, use the `poweradm` command as follows:

```
# poweradm set suspend-enable=true
# poweradm get suspend-enable
```

- By default, the `administrative-authority` SMF service property of the `poweradm` command is set to the `platform` value. However, the power service goes into maintenance mode if the `administrative-authority` service property is set to the `smf` value *before* the `time-to-full-capacity` and `time-to-minimum-responsiveness` values have been set. If this problem occurs, you can recover as follows:

  ```
  # poweradm set administrative-authority=none
  # poweradm set time-to-full-capacity=
  # poweradm set time-to-minimum-responsiveness=
  # svcadm clear power
  # poweradm set administrative-authority=smf
  ```

- The GNOME power manager (GPM) feature, which runs when the GUI starts, changes the power management settings. This behavior is intentional to enable the integration of power management administration with GNOME Desktop behavior. See "Managing System Power Services" in *Managing System Information, Processes, and Performance in Oracle Solaris 11.3*.

System Configuration Tools Changes

One option for reconfiguring your system's settings is the `sysconfig` utility (also called the System Configuration Interactive (SCI) Tool). The SCI tool supports the configuration of freshly installed or unconfigured systems and is designed to provide system configuration for newly created non-global zones during text installations. You can use the SCI tool interactively or non-interactively.

There are three operations that you can perform with the `sysconfig` utility: unconfiguration, configuration, and profile creation. You use the `unconfigure` subcommand to unconfigure an entire system. This command leaves the system in a completely unconfigured state.

Use the `configure` subcommand to reconfigure the existing settings for any of the following functional groupings:

- `date_time`
- `identity`
- `keyboard`
- `location`
- `naming_services`
- `network`

- `support`
- `system`
- `users`

For example, you would reconfigure all of the system's existing network settings as follows:

```
# sysconfig configure -g network
```

Use the following command to reconfigure a system's existing naming services:

```
# sysconfig configure -g network,naming_services
```

The `-g` option specifies which functional grouping to reconfigure.

You can also reconfigure an Oracle Solaris instance by specifying an existing configuration XML profile, as shown in this example:

```
# sysconfig configure -c profile-name.xml
```

If you do not specify an existing configuration profile prior to an installation, the SCI tool launches during the installation process. The SCI tool enables you to provide specific configuration information for that Oracle Solaris instance. The SCI tool consists of a series of interactive panels that enable you to provide configuration information as part of a text installation. You can also run the tool on an installed Oracle Solaris system to create a new system configuration profile that is based on specifications that you provide.

Start the SCI tool from the command line as follows:

```
# sysconfig configure
```

See `sysconfig`(1M) and Chapter 6, “Unconfiguring or Reconfiguring an Oracle Solaris Instance” in *Installing Oracle Solaris 11.3 Systems*.

System Registration and Customer Support Changes

Oracle Configuration Manager is used to personalize and enhance the customer support experience by collecting configuration information and uploading it to the Management Repository. This information is then analyzed by customer support representatives to provide better service to customers. Benefits of using this feature include reduced time for problem resolution and problem avoidance, as well as access to best practices and the Oracle knowledge base. In some Oracle Solaris 10 releases, the Auto Registration feature performs a similar function. Starting with the Oracle Solaris 10 1/13 release, Oracle Configuration Manager replaces the Auto Registration feature.

You can configure the Oracle Configuration Manager and the Oracle Auto Service Request (ASR) features during an interactive installation, if you plan to install these features on your system. Several options are available to choose from during an installation, including the ability to start Oracle Configuration Manager in the *disconnected mode*. This option replaces the "opt out" choice that is supported in the Oracle 11 11/11 release. If you choose the disconnected mode option, no data is sent to My Oracle Support during the first reboot after an installation. Note that you can manually activate Oracle Configuration Manager later. See "Using Oracle Configuration Manager" in *Installing Oracle Solaris 11.3 Systems*.

ASR is a secure, customer-installable feature of your Oracle or Sun hardware warranty and Oracle Premier Support for Systems. ASR assists in resolving specific hardware faults that occur by automatically opening service requests for Oracle's qualified server, storage, Exadata and Exalogic systems. The Oracle Auto Service Request is integrated with My Oracle Support. For more information, go to `https://www.oracle.com/technetwork/systems/asr/overview/index.html`.

Boot, Recovery, Platform, Hardware, and Disk Labeling Changes

An Oracle Solaris 11 system boots from a ZFS root file system by default and the ZFS root file system is contained within a ZFS root pool named `rpool`. Creating a UFS file system is still supported in Oracle Solaris 11, but you can no longer boot from a UFS or a Solaris Volume Manager root file system.

Review the following information, as it impacts the way the system is booted for recovery purposes:

- If you use a system's service processor (SP) or ILOM to recover from a system problem, accessing a system's SP or ILOM is identical to previous releases. The differences mostly pertain to how the system is booted after you get to a SPARC based system's OBP `ok` prompt or to an x86 based system's firmware screen (BIOS or UEFI).
- In Oracle Solaris 10, you use flash archive features to create a copy of a UFS or ZFS root environment and then restore the flash archive to recover the system environment, in the case of a system or device failure. In this release, you can create and deploy Oracle Solaris Unified Archives to perform system recovery and cloning operations. Oracle Solaris Unified Archives are system archives that can contain one or more archived instances of the OS. Each instance is an independently referenced system. An instance is defined as a boot environment in either a global or a non-global zone. Each system archive can contain any number of global and non-global zones. See *Using Unified Archives for System Recovery and Cloning in Oracle Solaris 11.3* for details.

x86: GRand Unified Bootloader Changes

GRUB 2 is the default boot loader, starting with Oracle Solaris 11.1. GRUB 2 replaces the original GRUB 0.97-based boot loader (GRUB Legacy) that is used in Oracle Solaris 10 and Oracle Solaris 11 11/11. GRUB 2 fully supports booting from disks that are larger than 2TB. GRUB 2 also supports the Unified Extensible Firmware Interface (UEFI) and the GUID Partition Table (GPT) partitioning scheme that is used in Oracle Solaris 11.

If you are transitioning from Oracle Solaris 10 to Oracle Solaris 11, note the following key differences between the two GRUB versions:

- **GRUB password protection** – Password protection for GRUB in included in this release though new `bootadm` subcommand options. These options enable you to set password protection for individual GRUB menu entries, as well as the entire GRUB menu. Other `bootadm` options enable you to add or delete authorized users. The `bootadm set-menu` command also has new options for adding and deleting a list of superusers who are permitted to use the GRUB command line, as well as edit and manage GRUB menu entries. See "What's New in Booting and Shutting Down a System" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.
- **GRUB menu changes** – Unlike the editable `menu.lst` file that is used by GRUB Legacy, GRUB 2 stores its configuration in the `grub.cfg` file. This file is syntactically different than the legacy `menu.lst` file and is also not meant to be edited. The `grub.cfg` file stores most of the GRUB configuration and is managed *solely* by using the `bootadm` command. To accommodate this change, the `bootadm` command includes several new subcommands, as well as a new `-P` option for administering the GRUB configuration for multiple root pools.

  Note - Because any GRUB configuration changes can automatically overwrite changes that you might make to the `grub.cfg` file, *do not* manually edit this file. Instead, use the `bootadm` command to update the GRUB configuration file. See Chapter 2, "Administering the GRand Unified Bootloader" in *Booting and Shutting Down Oracle Solaris 11.3 Systems* and `bootadm`(1M).

- **Managing non-Solaris boot entries** – GRUB 2 includes an additional configuration file named `custom.cfg`. You use this file to add custom menu entries to the GRUB configuration. The `custom.cfg` file does not exist on the system by default. You must create the file and store it in the same location as the `grub.cfg` file (`/`*pool-name*`/boot/grub/`). During the boot process, GRUB checks for the existence of the `custom.cfg` file in the toplevel dataset of the root pool (`boot/grub`). If the file exists, GRUB sources the file and then processes any commands within the file as if the contents were actually part of the `grub.cfg` file. See "Customizing the GRUB Configuration" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

If you are running an Oracle Solaris release that supports GRUB Legacy and are moving to a release that supports GRUB 2, see "Upgrading Your GRUB Legacy System to a Release That Supports GRUB 2" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

Firmware, Disk Labeling, and EEPROM Changes

If you are transitioning from Oracle Solaris 10, note the following feature changes:

- **64-Bit UEFI firmware support** – Oracle Solaris 11 supports x86 based systems with 64-bit UEFI firmware. An installation on UEFI firmware is supported through the DVD, USB, and network installation methods. UEFI version 2.1+ is required.

  If you are booting a system with UEFI firmware from the network, the boot process has changed slightly. See "Booting Systems With UEFI and BIOS Firmware From the Network" in *Booting and Shutting Down Oracle Solaris 11.3 Systems* for more details.
- **GPT labeled disk support** – GPT labeled disks are supported on both SPARC and x86 platforms. Installing an x86 or SPARC based system with GPT-aware firmware applies a GPT disk label on the root pool disk that uses the entire disk in most cases. For SPARC based systems that support a GPT labeled boot disk, see "SPARC: GPT Labeled Disk Support" in *Oracle Solaris 11.3 Release Notes*"Firmware Issues" in *Oracle Solaris 11.3 Release Notes* for information about how to apply the GPT-aware firmware update. Otherwise, installing Oracle Solaris on a SPARC based system applies an SMI (VTOC) label to the root pool disk with a single slice 0.
- **Setting EEPROM variables on UEFI enabled systems** – For UEFI enabled systems, the parameters are stored in two places: Oracle Solaris specific variables are stored in the `bootenv.rc` file and UEFI specific variables are set in the NVRAM store. Unlike SPARC based systems with the OpenBoot PROM (OBP), Oracle Solaris variables are not consumed by UEFI firmware. To enable the availability of UEFI specific variables available, you can use the `eeprom` command with the `-u` option. Most UEFI variables are in a binary format and are translated to a readable format. When translation is not possible, a hexdump is printed. See `eeprom`(1M) for details of this change.
- **Installing boot blocks** – You use the `bootadm install-bootloader` command to install or reinstall the boot loader on both SPARC and x86 based systems. This command replaces the `installboot` command on SPARC platforms and the `installgrub` command x86 platforms. See `bootadm`(1M).

Additional Boot, Platform, and Hardware Changes

Note the following boot, platform, and hardware feature changes:

- **x86 platform support is 64-bit only** – Support for booting a 32-bit kernel on x86 platforms has been removed. Systems that have 32-bit hardware must either be upgraded to 64-bit hardware or continue to run Oracle Solaris 10.

  Note - 32-bit applications are not impacted by this change.

- **Bitmapped console support** – Support for high resolution and color depth consoles has been added to Oracle Solaris. By default, your machine will boot with a 1024x768x16-bit console, unless your video card does not support this setting. In which case, the setting will fall back to 800x600, then finally to 640x480. You can control the console type (and also the older VGA TEXT 640x480 console) through both kernel parameters and through options that you specify by editing the GRUB menu at boot time as follows:

  ```
  -B console={text|graphics|force-text}
  ```

  See "Redirecting the Oracle Solaris Console at Boot Time" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

- **Fast Reboot support on x86 and SPARC platforms** – On x86 platforms, a fast reboot implements an in-kernel boot loader that loads the kernel into memory and then switches to that kernel. For SPARC based systems that support the Fast Reboot feature, the boot process is accelerated by skipping certain POST tests.

  The Fast Reboot feature works differently on SPARC platforms than it does on x86 platforms. To initiate a fast reboot of a SPARC based system, use the `-f` option with the `reboot` command. Because a fast reboot is the default behavior on x86 platforms, the `-f` option is not required. Use either the `reboot` command or the `init 6` command to initiate a fast reboot of an x86 based system. The Fast Reboot feature is managed through SMF properties that you can enable or disable as needed. See "Accelerating the Reboot Process" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

- **Removal of support for SPARC `sun4u` architecture** – With the exception of the M-series (OPL) hardware, you cannot boot Oracle Solaris 11 on the `sun4u` architecture. If you attempt to boot Oracle Solaris 11 on one of these systems, the following error message is displayed:

  ```
  Rebooting with command: boot
  Error: 'cpu:SUNW,UltraSPARC-IV+' is not supported by this release of Solaris.
  NOTICE: f_client_exit: Program terminated!
  ```

Booting a System for Recovery

If an Oracle Solaris 11 system becomes unbootable, you most likely will need to perform a recovery boot. You can boot from installation media or from a backup BE.

If you need to perform complete system (bare metal) recovery, see "How to Create a Recovery Archive" in *Using Unified Archives for System Recovery and Cloning in Oracle Solaris 11.3*.

The following error and recovery scenarios are similar to previous releases:

- You can use the `boot -a` command to bypass a problem in the `/etc/system` file. When prompted, use syntax that is similar to the following:

  ```
  Name of system file [/etc/system]:  /dev/null
  ```

  Press Return at the other prompts, as needed.
- Consider creating a backup BE before you make any system configuration changes. Having a backup BE enables you to boot to another BE if some error occurs during the image update process. Several different `pkg` operations will create a backup BE on the system. You do not need to separately create a backup BE before you perform a `pkg` operation because you can specify options with the `pkg` command that will create the backup BE for you. Also, you might want to create a clone BE before using the `sysconfig` command on your system. For instructions on booting from a backup BE, see "How to Boot From a Backup BE for Recovery Purposes" on page 124.
- Boot from the installation media or from an install server over the network to recover from a problem that is preventing the system from booting or to recover from a lost `root` password.

Note - On SPARC based systems, the `boot net:dhcp` command replaces the `boot net` command that is used in Oracle Solaris 10 releases.

- Boot a system in single-user mode to resolve a minor problem, such as correcting the root shell entry in the `/etc/passwd` file or changing a NIS server.
- Resolving a boot configuration problem generally involves importing the root pool, mounting the BE, and fixing the problem, for example reinstalling the x86 boot loader if it has become corrupted.

▼ How to Boot From a Backup BE for Recovery Purposes

Booting the failsafe archive is no longer supported on SPARC and x86 platforms. Whenever possible, use up-to-date backup BEs for recovery purposes. BEs are bootable instances of the Oracle Solaris image, plus any other application software packages that are installed into that image.

Note - When updating packages, you can specify one or more of the BE options with the `pkg` command or set your image policy to always create a backup BE every time you install your system or update a package. In this way, you do not have to be concerned about your backup BE being up-to-date because it was cloned immediately before the installation or update was performed.

If the system does not boot from the active BE, select a backup BE from which to boot.

- **Boot from a backup BE as follows:**

  - **SPARC: Boot the system so that you can select an alternate or backup BE.**

    a. **Boot with the `boot -L` command.**

    ```
    ok boot -L
    ```

    b. **Select an alternate or backup BE.**

    ```
    Boot device: /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/disk@0,0:a
    File and args: -L
    1 Solaris11.3_SPARC
    2 solaris11.2-backup
    Select environment to boot: [ 1 - 2 ]: 2
    ```

    c. **Boot the backup BE.**

    After you select the BE from which to boot, identify the on-screen boot path and type that information at the prompt.

    ```
    To boot the selected entry, invoke:
    boot [<root-device>] -Z rpool/ROOT/solaris-backup

    Program terminated
    {0} ok boot -Z rpool/ROOT/solaris-backup
    ```

    If the system does not boot, review the additional boot recovery steps in "How to Boot a System For Recovery Purposes" on page 126.

  - **x86: Boot the system to identify the alternate or backup BE from the GRUB menu.**

    a. **When the GRUB menu is displayed, identify the backup BE.**

b. **Select the backup BE, then press Return to boot that entry.**
If the system does not boot from the backup BE, review the additional boot recovery steps in "How to Boot a System For Recovery Purposes" on page 126.

▼ How to Boot a System For Recovery Purposes

1. **Select the appropriate boot method:**

   - **x86: Live Media** – Boot from the installation media and use a GNOME terminal for the recovery procedure.
   - **SPARC: Text installation** – Boot from the install media or from the network, and select option `3 Shell` from the text installation screen.
   - **x86: Text installation** – From the GRUB menu, select the `Text Installer and command line` boot entry, then select the option `3 Shell` from the text installation screen.
   - **SPARC: Automated installation** – Use the following command to boot directly from an installation menu that allows you to exit to a shell.

     ```
     ok boot net:dhcp
     ```
   - **x86: Automated installation** – Booting from an install server on the network requires a PXE boot. Select the `Text Installer and command line` entry from the GRUB menu. Then, select the option `3 Shell` from the text installation screen.

   For example, after the system is booted, select option `3 Shell`.

   ```
   1  Install Oracle Solaris
   2  Install Additional Drivers
   3  Shell
   4  Terminal type (currently xterm)
   5  Reboot

   Please enter a number [1]: 3
   To return to the main menu, exit the shell
   #
   ```

2. **Select from the following boot recovery problems:**

   - Resolve a bad root shell by booting the system to single-user mode and correcting the shell entry in the `/etc/passwd` file.

     On an x86 based system, edit the selected boot entry in the GRUB menu, then add the `-s` kernel argument to the end of the `$kernel` line.

     On a SPARC based system, shut down the system and boot to single-user mode. After you log in as the `root` user, edit the `/etc/passwd` file, and fix the root shell entry.

```
# init 0
ok boot -s
Boot device: /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/disk@0,0:a ...
SunOS Release 5.11 Version 11.3 64-bit
Copyright (c) 1983, 2013, Oracle and/or its affiliates. All rights reserved.
Booting to milestone "milestone/single-user:default".
Hostname: systema.domain
Requesting System Maintenance Mode
SINGLE USER MODE

Enter user name for system maintenance (control-d to bypass): root
Enter root password (control-d to bypass): xxxxxxx
single-user privilege assigned to root on /dev/console.
Entering System Maintenance Mode

Aug  3 15:46:21 su: 'su root' succeeded for root on /dev/console
Oracle Corporation      SunOS 5.11      11.3    July 2013
su: No shell /usr/bin/mybash.  Trying fallback shell /sbin/sh.
root@systema.domain:~# TERM =vt100; export TERM
root@systema.domain:~# vi /etc/passwd
root@systema.domian:~# <Press control-d>
logout
svc.startd: Returning to milestone all.
```

- Resolve a corrupt boot loader problem.

  First, boot from media or the network by using one of the boot methods that are listed in Step 1. Then, import the root pool.

  ```
  # zpool import -f rpool
  ```

  Note - Do not use the `-f` option unless you are sure that you want to overwrite the boot loader with the version that is on the media. See "Installing GRUB 2 by Using the bootadm install-bootloader Command" in *Booting and Shutting Down Oracle Solaris 11.3 Systems*.

  Then, reinstall the boot loader as follows:

  ```
  # bootadm install-bootloader -f  -P rpool
  ```

  Where `-f` forces the installation of the boot loader and bypasses any checks related to not downgrading the version of the boot loader on the system. The `-P` option specifies the root pool.

  Exit and reboot the system.

```
# exit
1  Install Oracle Solaris
2  Install Additional Drivers
3  Shell
4  Terminal type (currently sun-color)
5  Reboot

Please enter a number [1]: 5
```

Confirm that the system boots successfully.

- Resolve an unknown `root` password that prevents you from logging into the system.

  First, you must boot from media or the network by using one of the boot methods that are listed in Step 1. Then, import the root pool (`rpool`) and mount the BE to remove the `root` password entry. This process is identical on SPARC and x86 platforms.

```
# zpool import -f rpool
# beadm list
be_find_current_be: failed to find current BE name
be_find_current_be: failed to find current BE name
BE                 Active Mountpoint Space  Policy Created
--                 ------ ---------- -----  ------ -------
solaris            -      -          11.45M static 2011-10-22 00:30
solaris-2          R      -          12.69G static 2011-10-21 21:04
# mkdir /a
# beadm mount solaris-2 /a
# TERM=vt100
# export TERM
# cd /a/etc
# vi shadow
<Carefully remove the unknown password>
# cd /
# beadm umount solaris-2
# halt
```

3. Set the root password by booting to single-user mode and setting the password.

This step assumes that you have removed an unknown `root` password in the previous step.

- **On an x86 based system, edit the selected boot entry in the GRUB menu, then add the `-s` option to the `$kernel` line.**

- **On a SPARC based system, boot the system to single-user mode, log in as root, and set the root password. For example:**

```
ok boot -s

Boot device: /pci@780/pci@0/pci@9/scsi@0/disk@0,0:a File and args: -s
SunOS Release 5.11 Version 11.3 64-bit
Copyright (c) 1983, 2012, Oracle and/or its affiliates. All rights
reserved.
Booting to milestone "milestone/single-user:default".
Hostname: systema.domain
Requesting System Maintenance Mode
SINGLE USER MODE

Enter user name for system maintenance (control-d to bypass): root
Enter root password (control-d to bypass): <Press return>
single-user privilege assigned to root on /dev/console.
Entering System Maintenance Mode
.
.
.
root@sysadma.domain:~# passwd -r files root
New Password: xxxxxx
Re-enter new Password: xxxxxx
passwd: password successfully changed for root
root@systema.central:~# <Press control-d>
logout
svc.startd: Returning to milestone all.
```

System Recovery and Cloning With the Oracle Solaris Unified Archives Feature

The Oracle Solaris Unified Archives feature supports multiple system archives that consist of one or more point-in-time system archive images in a single file format. Unified Archives can contain one or more archived instances of Solaris from a single host. You can select individual installed zones to include during archive creation, while the host itself is optional. Unified archives provide similar functionality to the Oracle Solaris Flash Archive installation method that is supported in Oracle Solaris 10.

You can deploy a unified archive to perform system recovery, cloning, or migration by using any of the following methods:

- AI installation method
- Oracle Solaris Zones utilities
- Unified Archive bootable media

In Oracle Solaris 10, the Oracle Solaris Flash Archive installation method is used. Introduced before the wide adoption of virtual systems, flash archives are designed to create and deploy OS instances for bare metal systems. Flash archives capture file system data from a running system and any system-related metadata. However, to support boot environments (BEs), the Image Packaging System (IPS), and the various virtualized technologies that are used in Oracle Solaris 11, a more flexible and robust archive solution was required. Unified Archives provide support for virtualized environments, such as zones, as well as cross platform portability within the same hardware architecture.

The `archiveadm` command enables you to create system archive images of a running Oracle Solaris system for the purposes of system cloning and recovery. You can also use the command to obtain information about existing archives and create bootable media from an archive. See `archiveadm`(1M).

For additional information, see *Using Unified Archives for System Recovery and Cloning in Oracle Solaris 11.3*.

Printer Configuration and Management Changes

The legacy LP print service has been replaced by the Common UNIX Printing System (CUPS). CUPS is a modular, open-source printing system that uses the Internet Printing Protocol (IPP) as the basis for managing printers, print requests, and print queues. CUPS supports network printer browsing and PostScript Printer Description-based printing options. CUPS also provides a common printing interface across a local network.

The following related changes are described in more detail:

- "Removal of the LP Print Service" on page 130
- "How to Set Up Your Printing Environment After an Installation" on page 132

Removal of the LP Print Service

The following important changes are a result of the removal of the LP print service:

- Solaris Print Manager is no longer available in the desktop. CUPS Print Manager replaces this tool. See *Configuring and Managing Printing in Oracle Solaris 11.3*.
- Several LP print commands, files, and services are no longer available. Some LP print commands, for example `lp`, `lpadmin`, `lpc`, `lpr` are still available. In Oracle Solaris 11, these commands are managed by CUPS. For a complete list of the commands, services, and files that have been removed, refer to "Removal of Legacy System Management Commands, Files, and Services" on page 19.

- Printer configuration that is stored in the NIS naming service in Oracle Solaris 10 is not used by CUPS. CUPS auto-discovers printers on a network, enabling you to print to these printers without any manual configuration. Administrators can share network printers that are configured by using CUPS by turning on the sharing feature. See "How to Unshare or Share a Printer" in *Configuring and Managing Printing in Oracle Solaris 11.3*.
- In Oracle Solaris 10 and previous releases, the `/etc/printers.conf` file is where details about all of the printers that are set up by using the LP print service is stored. In Oracle Solaris 11, this file is no longer generated after a fresh installation. Any information about printers that were configured by using `lp` print commands is removed. The resulting behavior is as though these printers were never configured on the system. Any previously configured printers must be reconfigured by using CUPS. Note that you do not need to delete existing printers prior to reconfiguring them. For information about setting up your printing environment to work with CUPS, see "How to Set Up Your Printing Environment After an Installation" on page 132.
- Printers that are configured on a per-user basis in the `~/.printers` file no longer work. Printer configuration is solely managed by using CUPS. The default printer can be set on a per-user basis, by setting either the `LPDEST` or `PRINTER` environment variables, or by using the new `lpoptions` command. The `lpoptions` command creates an `~/.lpoptions` file that has the default printer entry listed within that file. By default, all print jobs are directed to this printer.

  List specific options for a printer as follows:

  ```
  # lpoptions -l printer-name
  ```

  Set the default destination or instance for the default printer by using the `-d` option:

  ```
  # lpoptions -d printer-name
  ```

  See "Setting a Default Printer" in *Configuring and Managing Printing in Oracle Solaris 11.3*.
- The `lp` entry in the `/etc/passwd` file is as follows:

  ```
  lp:x:71:8:Line Printer Admin:/:
  ```

  The `lp` entry in the `/etc/group` file remains as it is in previous releases.

See Chapter 1, "Setting Up and Administering Printers by Using CUPS (Overview)" in *Configuring and Managing Printing in Oracle Solaris 11.3*.

▼ How to Set Up Your Printing Environment After an Installation

Use the following procedure to set up your printing environment to work with CUPS after a fresh installation.

1. **Verify that the `cups/scheduler` and the `cups/in-lpd` SMF services are online.**

```
# svcs -a | grep cups/scheduler
# svcs -a | grep cups/in-lpd
```

2. **If these services are not online, enable them.**

```
# svcadm enable cups/scheduler
# svcadm enable cups/in-lpd
```

3. **Check that the `printer/cups/system-config-printer` package is installed.**

```
# pkg info print/cups/system-config-printer
```

   - **If the package is already installed, you are ready to configure printers by using CUPS.**
   - **If the package is not installed, install the package:**

```
# pkg install print/cups/system-config-printer
```

Next Steps For instructions, see "Setting Up and Administering Printers by Using CUPS Command-Line Utilities" in *Configuring and Managing Printing in Oracle Solaris 11.3*.

Internationalization and Localization Changes

Note the following internationalization and localization changes:

- **Language and locale support** – Oracle Solaris 11 supports over 200 locales. By default, only a core set of locales is installed on the system. Core locales typically provide better support at the level of localized messages than locales that are available for additional installation. Specific Oracle Solaris components, such as the installers or Package Manager, are localized for core locales *only*. Note that localized messages for third-party software, for example GNOME and Firefox, include additional locales.

  The core set of locales support the following languages:

  - Chinese – Simplified (`zh_CN.UTF-8`).

- Chinese – Traditional (`zh_TW.UTF-8`).
- English (`en_US.UTF-8`)
- French (`fr_FR.UTF-8`)
- German (`de_DE.UTF-8`).
- Italian (`it_IT.UTF-8`).
- Japanese (`ja_JP.UTF-8`).
- Korean (`ko_KR.UTF-8`)
- Portuguese – Brazilian (`pt_BR.UTF-8`).
- Spanish (`es_ES.UTF-8`).

Other notable core locale changes include the addition of the Portuguese – Brazilian locale and the removal of the Swedish locale.

- **Other locale changes** – Starting with Oracle Solaris 11.1, the following locale changes are implemented:
  - Japanese (`ja_JP.UTF-8@cldr`) locale – This locale is a new variant of the Japanese UTF-8 locale (`ja_JP.UTF-8`) that conforms to the Unicode Common Locale Data Repository (CLDR) for the Japanese locale. The locale is an optional component that is installable from the `system/locale/extra` package.
  - Locale data for Simplified Chinese, Traditional Chinese, Korean, and Thai UTF-8 locales has been updated to support Unicode 6.0.
- **Language and locale packaging** – In Oracle Solaris 10, optional package components, such as documentation, localization, and debug files are split into separate packages. However, in Oracle Solaris 11, IPS enables you to store these various package components in the same package by using special tags that are called *facets*. Facets simplify the packaging process, as well as minimize disk space usage. Locale facets are used to mark files or actions that are language or locale-specific.

  Display the status of the facets on a system as follows:

  ```
  $ pkg facet
  ```

  You can use the `nlsadm` command to administer locales. This command provides a consolidated and convenient way to administer national language properties. The `nlsadm` command replaces the `localeadm` command that is used in Oracle Solaris 10.

  For example, you would install the `Danish` locale and any available translations as follows:

  ```
  # nlsadm install-locale da_DK.UTF-8
  ```

  For more information, see the `nlsadm(1M)` man page.
- **Setting a system's default locale** – In Oracle Solaris 10, the default system locale is configured in the `/etc/default/init` file. Starting with Oracle Solaris 11, this file is

obsoleted and the configuration has moved to the corresponding properties of the `svc:/system/environment:init` SMF service. See "Locale, Timezone, and Console Keymap Configuration Changes" on page 134.

- **Short form locales** – Oracle Solaris 10 supports a number of short form locale names that do not follow the *language_country*.*encoding*[@*modifier*] format, for example, `ja`,`de`, `de_AT`, and so on. These locales are not present in Oracle Solaris 11 in their original form, only as aliases to fully qualified locale names through the `locale_alias` mechanism. Starting with Oracle Solaris 11, you should use fully qualified locale names. Or, if possible, use UTF-8 locales. See the end-of-feature announcements at `https://www.oracle.com/technetwork/systems/end-of-notices/eonsolaris11-392732.html`.
- **Locale aliasing** – Locale aliases are new. Locale name aliases are accepted and mapped to the corresponding canonical locale names. For example, the `de` locale is mapped to the canonical `de_DE.ISO8859-1` locale. For all of the locale name mappings, see the `locale_alias(5)` man page.

Locale, Timezone, and Console Keymap Configuration Changes

In Oracle Solaris 10, locale, timezone, and console keymap configuration is set in the `/etc/default/init` file. In Oracle Solaris 11, you manage this configuration through the following SMF services:

- System locale – `svc:/system/environment:init`
- Timezone – `svc:/system/timezone:default`
- Console keymap – `svc:/system/keymap:default`

Use the `nlsadm` command to display and set these national language properties. The following examples show how to set these properties by using the `nlsadm` command.

Change the default locale to `fr_FR.UTF-8` as follows:

```
# nlsadm set-system-locale fr_FR.UTF-8
```

Set the timezone to `Europe/Paris` as follows:

```
# nlsadm set-timezone Europe/Paris
```

Set the console keymap to `US-English` as follows:

```
# nlsadm set-console-keymap US-English
```

For other date and time configuration changes, see “Reconfiguring Date and Time Before and After an Installation” on page 38.

♦ ♦ ♦ CHAPTER 9

Managing Security

This chapter describes security feature changes in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Security Feature Changes

Note the following key security changes:

- **Address Space Layout Randomization (ASLR)** – Starting with Oracle Solaris 11.1 ASLR randomizes addresses that are used by a given binary. ASLR causes certain types of attacks that are based on knowing the exact location of certain memory ranges to fail and detects the attempt when it likely stops the executable. Use the `sxadm` command to configure ASLR. Use the `elfedit` command to change the tagging on a binary. See `sxadm`(1M) and `elfedit`(1).
- **Administrative Editor** – You can use the `pfedit` command to edit system files. If defined by the system administrator, the value of this editor is `$EDITOR`. If undefined, the editor defaults to the `vim` command. Start the editor as follows:

  ```
  $ pfedit system-filename
  ```

  In this release, auditing is on by default. For a secure system, use the interfaces that are always audited when auditing of administrative actions is turned on. Because `pfedit` use is always audited, it is the preferred command for editing system files. See `pfedit`(1M) and Chapter 3, "Controlling Access to Systems" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.
- **Auditing** – Auditing is a service in Oracle Solaris 11 and is enabled by default. No reboot is required when disabling or enabling this service. You use the `auditconfig` command to view information about audit policy and to change audit policy. The auditing of public

objects generates less noise in the audit trail. In addition, auditing of non-kernel events has no performance impact.

For information about creating a file system dedicated to audit files, see "How to Create ZFS File Systems for Audit Files" in *Managing Auditing in Oracle Solaris 11.3*.

- **Audit Remote Server (ARS)** – ARS receives and stores audit records from a system that is configured with an active `audit_remote` plugin. To distinguish an audited system from an ARS, the audited system can be termed the locally audited system. Refer to the information about the `-setremote` option in `auditconfig`(1M).
- **Compliance assessment** – Use the `compliance` command to automate compliance assessment and to guide remediation for compliance on a given security policy or benchmark versus other types of compliance requirements. See *Oracle Solaris 11.3 Security Compliance Guide* and `compliance`(1M).
- **Basic Audit Reporting Tool (BART)** – The default hash that is used by BART is SHA256, not MD5. See Chapter 3, "Verifying File Integrity by Using BART" in *Securing Files and Verifying File Integrity in Oracle Solaris 11.3*.
- `cryptoadm` **command changes** – As part of the implementation of the `/etc/system.d` directory for easier packaging of Oracle Solaris kernel configuration, the `cryptoadm` command has also been updated to write to files in this directory rather than to the protected files in the `/etc/system` directory. See `cryptoadm`(1M).
- **Cryptographic Framework** – This feature includes more algorithms, mechanisms, plugins, and support for Intel and SPARC T4 hardware acceleration. Also, Oracle Solaris 11 provides better alignment with the NSA Suite B cryptography. Many of the algorithms in the framework are optimized for x86 platforms with the SSE2 instruction set. For more information about T-Series optimizations, see "Cryptographic Framework Optimizations for SPARC Based Systems" in *Managing Encryption and Certificates in Oracle Solaris 11.3*.
- `dtrace` **command changes** – As part of the implementation of the `/etc/system.d` directory for easier packaging of Oracle Solaris kernel configuration, the `dtrace` command has also been updated to write to files in this directory rather than to the protected files in the `/etc/system` directory. See `dtrace`(1M).
- **FIPS 140-2 Level 1 cryptography** – A system that is running in FIPS 140-2 mode has enabled at least one provider of FIPS 140-2 cryptography. Some applications use FIPS 140-2 cryptography automatically, for example the passwd command. Other applications must be enabled in FIPS 140-2 mode, for example, Secure Shell, while other applications run in FIPS 140-2 mode when their provider is enabled and the application uses FIPS 140-2 cryptography only, for example, Kerberos, IPsec, and the Apache HTTP Server. for more information, see *Using a FIPS 140-2 Enabled System in Oracle Solaris 11.3*.
- **Kerberos DTrace providers** – A new DTrace USDT provider that provides probes for Kerberos messages (Protocol Data Unit) has been added. The probes are modeled after the Kerberos message types that are described in RFC 4120.
- **Key Management enhancements:**

  - PKCS #11 keystore support for RSA keys in the Trusted Platform Module
  - PKCS #11 access to Oracle Key Manager for centralized enterprise key management
- `lofi` **command changes** – The `lofi` command supports the encryption of block devices in this release. See `lofi`(7D).
- `nxheap` **and** `nxstack` **security extensions** – Use the `nxheap` and `nxstack` security extensions to systematically make the stack and heap of all Oracle Solaris processes non-executable. The `nxstack` security extension replaces the `noexec_user_stack` system variable. For more information, see "Protecting the Process Heap and Executable Stacks From Compromise" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.
- One-time passwords (OTP) are supported by installing the `system/security/otp` package. See Chapter 8, "Using One-Time Passwords for Multifactor Authentication in Oracle Solaris" in *Managing Kerberos and Other Authentication Services in Oracle Solaris 11.3*.
- `profiles` **command changes** – In Oracle Solaris 10, this command is only used to list profiles for a specific user or role, or a user's privileges for specific commands. Starting with Oracle Solaris 11, you can create and modify profiles in files and in LDAP by using the `profiles` command, See `profiles`(1).
- `rstchown` **property** – The `rstchown` tunable parameter that is used in previous releases to restrict `chown` operations is now a ZFS file system property and is also a general file system mount option. See *Managing ZFS File Systems in Oracle Solaris 11.3* and the `mount`(1M) man page.

  If you attempt to set this obsolete parameter in the `/etc/system` file, the following message is displayed:

  ```
  sorry, variable 'rstchown' is not defined in the 'kernel'
  ```
- `sudo` **command** – This command generates Oracle Solaris audit records when running other commands. The command also drops the `proc_exec` basic privilege, if the `sudoers` command entry is tagged as `NOEXEC`.
- **Verified boot** – Secures a system's boot process and protects a system from threats, such as corruption of kernel modules, the insertion or substitution of malicious programs that masquerade as legitimate kernel modules, as well the unintended installation of third-party modules that might violate policies that control site changes. See "Using Verified Boot" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*.
- **ZFS file system encryption** – ZFS file system encryption is designed to keep your data secure. See "Encrypting ZFS File Systems" on page 145.

Network Security Features

The following network security features are supported:

- **Internet Key Exchange (IKE)** – IKE Version 2 (IKEv2) provides automatic key management for IPsec using the latest version of the IKE protocol. IKEv2 and IPsec use cryptographic algorithms from the Cryptographic Framework feature of Oracle Solaris. IKEv2 includes more Diffie-Hellman groups and can also use Elliptic Curve Cryptography (ECC) groups.
- **IKE and IPSec support latest algorithm mechanisms** – Both features can use the latest algorithm mechanisms from the Cryptographic Framework. Also, in this release, Camellia is available. See Chapter 10, "About Internet Key Exchange" in *Securing the Network in Oracle Solaris 11.3*.
- **IP Security Architecture (IPsec)** – IPsec includes AES-CCM and AES-GCM modes and is capable of protecting network traffic for the Trusted Extensions feature of IKEv2. See Chapter 8, "About IP Security Architecture" in *Securing the Network in Oracle Solaris 11.3*.
- **Packet Filter Firewall** – This feature provides an alternative firewall to IPFilter. PF is based on a current version of OpenBSD Packet Filter, and is highly integrated with SMF and other Oracle Solaris features. See Chapter 4, "OpenBSD Packet Filter Firewall in Oracle Solaris" in *Securing the Network in Oracle Solaris 11.3*.
- **Kerberos** – Starting with Oracle Solaris 11.3, Kerberos is based on a recent version of MIT Kerberos. See "What's New in Kerberos in Oracle Solaris 11.3" in *Managing Kerberos and Other Authentication Services in Oracle Solaris 11.3*.
- **OpenSSL 1.0.1** – Starting with Oracle Solaris 11.2, OpenSSL 1.0.1 is supported. This version of OpenSSL provides you with a choice between performance or FIPS 140-2 compliance. See `https://blogs.oracle.com/observatory/entry/openssl_on_solaris_11_2`.
- **Secure by Default** – Secure by Default feature minimizes network exposure. In Oracle Solaris 10, this feature was introduced, but was turned off by default and had to be enabled manually. Starting with Oracle Solaris 11, this feature is enabled by default, and Secure Shell is the only network service that permits remote access. You can selectively enable remote access by other services.
- **Secure Shell** – Two versions of .Secure Shell are supported, the legacy SunSSH, and a current OpenSSH version. See "What's New in Secure Shell in Oracle Solaris 11.3" in *Managing Secure Shell Access in Oracle Solaris 11.3*
- **SSL kernel proxy** – See Chapter 3, "Web Servers and the Secure Sockets Layer Protocol" in *Securing the Network in Oracle Solaris 11.3*.

Pluggable Authentication Module Changes

The following Pluggable Authentication Module (PAM) changes are introduced:

- **Module to enable per-user PAM stacks** – Enables you to configure the PAM authentication policy on a per-user basis, when used in conjunction with the new `pam_policy` key (`user_attr(4)`). You can assign `pam_policy` to a user, as shown in this example:

  ```
  # usermod -K pam_policy=krb5_only username
  ```

  See `pam_user_policy(5)`.
- **PAM configuration in** `/etc/pam.d` – Adds support for configuring PAM by using per-service files. As a result, the contents of the `/etc/pam.conf` file have been migrated to multiple files within the `/etc/pam.d/` directory, based on the relevant PAM service name. This mechanism is the correct method for configuring PAM in Oracle Solaris and is the default method that is used for all *new* installations. The `/etc/pam.conf` file is still consulted, so changes to this file continue to be recognized.

  If you have never edited the `/etc/pam.conf` file, the file only contains comments that direct you to the per-service equivalents in the `/etc/pam.d/` directory. If you previously edited the `/etc/pam.conf` file, for example, to enable LDAP or Kerberos, a new file name named `/etc/pam.conf.new` is delivered with the changes that you made. See `pam.conf(4)`.
- `definitive` **flag added to** `pam.conf` – The `pam.conf` file includes the `definitive control_flag` in this release. See `pam.conf(4)`.

Removed Security Features

The following security features are removed:

- **Automated Security Enhancement Tool (ASET)** – The ASET functionality is replaced by a combination of IP Filter, which includes `svc.ipfd`, BART, SMF, the security compliance tool (starting with Oracle Solaris 11.2), as well as other security features that are supported in this release.
- **Smartcard** – Using a smartcard on a Sun Ray is no longer available. For current smartcard support, see Chapter 7, “Using Smart Cards for Multifactor Authentication in Oracle Solaris” in *Managing Kerberos and Other Authentication Services in Oracle Solaris 11.3*.

Roles, Rights, Privileges, and Authorizations

The following information describes how roles, rights, privileges, and authorizations work Oracle Solaris 11:

- **Assign versus delegate authorizations** – Oracle Solaris provides authorizations for delegating specific administrative rights to individual users and roles to implement separation of duty. In Oracle Solaris 10, authorizations ending in `.grant` are required to delegate an authorization to another user. Starting with Oracle Solaris 11, two new suffixes, `.assign` and `.delegate`, are used, for example, `solaris.profile.assign` and `solaris.profile.delegate`. The former grants the right to delegate any rights profile to any user or role. The latter is more restrictive, in that only the rights profiles that are already assigned to the current user can be delegated. Since the `root` role is assigned `solaris.*`, this role can assign any authorization to any user or role. As a safety measure, no authorizations that end in `.assign` are included in any profiles by default.
- `groupadd` **command changes** – At group creation, the system assigns the `solaris.group.assign/`*groupname* authorization to the administrator. This authorization gives the administrator complete control over that group, enabling the administrator to modify or delete the *groupname*, as needed. See the `groupadd`(1M) and `groupmod`(1M) man pages.
- **Media Restore rights profile** – This rights profile and its associated set of authorizations can escalate the privileges of a non `root` account. The profile exists, but is not part of any other rights profile. Because the `Media Restore` rights profile provides access to the entire root file system, its use is a possible escalation of privilege. Deliberately altered files or substitute media could be restored. By default, the `root` role includes this rights profile.
- **Primary Administrator profile removed** – The initial user that is created at installation time is given the following roles and rights:
  - `root` role
  - `System Administrator` rights profile
  - Access to the `sudo` command for all commands that are run as `root`
- **Role authentication** – You can specify either `user` or `role` for the `roleauth` keyword.

  You can determine which password has been assigned to the `root` role as follows:

  ```
  # userattr roleauth root
  ```

  No output means the `root` account has not been customized, meaning the password is the Oracle Solaris default and not the user's password.

  See `user_attr`(4).
- **root as a role** – `root` is a role by default in Oracle Solaris 11, therefore, not *anonymous* and cannot remotely log in to a system. For information about changing the `root` role to a user,

see "How to Change the root Role Into a User" in *Securing Users and Processes in Oracle Solaris 11.3*.

- To list the basic privileges in your shell, run the `ppriv -l basic` command.
- To list the profile shell versions of regular shells, see the `pfexec`(1) man page.
- **Rights profiles** – The `user_attr`, `prof_attr`, and `exec_attr` databases are read-only. To add or modify a rights profile, use the `profiles` command. See "About Rights Profiles" on page 143.
- **Stop Rights profile** – This profile enables administrators to create restricted accounts. See "More About Rights Profiles" in *Securing Users and Processes in Oracle Solaris 11.3*.
- `pfsh` *script* **command** – This command runs the same as the `pfsh -c` *script* command. Previously, commands within a script could not take advantage of using rights profiles unless the script specified a profile shell in the first line. This rule required you to modify any scripts to use rights profiles, which is now unnecessary.
- `pfexec` **command** – This command is no longer `setuid` root. The new `PF_PFEXEC` process attribute is set when the `pfexec` command or a profile shell is executed. Then, the kernel sets the appropriate privileges on `exec`. This implementation ensures that sub-shells are empowered or restricted, as appropriate. Also, the `pfexec` command prompts the user to re-authenticate if the specified command is included in a rights profile that has been assigned by using the `auth_profiles` keyword.

  When the kernel is processing an `exec`(2), it treats `setuid` to `root` differently. Note that `setuid` to any other `uid` or `setgid` is as it was previously. The kernel searches for an entry in the `Forced Privilege` rights profile in `exec_attr`(4) to determine which privileges the program should run with. Instead of having the program start with uid `root` and all privileges, the program runs with the current uid and only the additional privileges that the `Forced Privilege` execution rights profile have assigned to that path name.

About Rights Profiles

Rights profiles are collections of authorizations and other security attributes, commands with security attributes, and supplementary rights profiles. Oracle Solaris provides many rights profiles. You can modify existing rights profiles, as well as create new ones. Note that rights profiles must be assigned in order, from most to least powerful.

For a list of provided rights profiles, see Chapter 8, "Reference for Oracle Solaris Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

Viewing and Using Privileges and Authorizations

When a user is directly assigned privileges, in effect, the privileges are in every shell. When a user is not directly assigned privileges, then the user must open a profile shell. For example, when commands with assigned privileges are in a rights profile that is in the user's list of rights profiles, then the user must execute the command in a profile shell.

To view privileges online, see `privileges(5)`. Privileges are displayed in the format that developers use. When you are assigned a privilege, it appears as, for example, `contract_event`, not `PRIV_CONTRACT_EVENT`.

```
$ man privileges
Standards, Environments, and Macros                 privileges(5)

NAME
privileges - process privilege model
...
The defined privileges are:

PRIV_CONTRACT_EVENT

Allow a process to request reliable delivery  of  events
to an event endpoint.

Allow a process to include events in the critical  event
set  term  of  a  template  which  could be generated in
volume by the user.
...
```

To view authorizations, use the `auths` command:

```
$ auths list
```

The output of this command produces a more readable summary (one per line) of the authorizations that are assigned to a user. Starting with Oracle Solaris 11.1, several new options have been added to the `auths` command. See Chapter 8, “Reference for Oracle Solaris Rights” in *Securing Users and Processes in Oracle Solaris 11.3* and the `auths(1)` man page.

File and File System Security Changes

The following changes pertain to file and file system security.

`aclmode` Property Reintroduced

The `aclmode` property that determines how the ACL permissions on a file are modified during a `chmod` operation is reintroduced in this release. The `aclmode` values are `discard`, `mask`, and `passthrough`. The `discard` default value is the most restrictive, and the `passthrough` value is the least restrictive.

`immutable`, `nounlink`, and `appendonly` Attributes

For information about how to protect files and zones by using these attributes, see "Examples of Setting Security-Relevant Attributes on ZFS Files" in *Securing Files and Verifying File Integrity in Oracle Solaris 11.3*.

Encrypting ZFS File Systems

In previous Oracle Solaris releases and in this release, the Cryptographic Framework feature provides the `encrypt`, `decrypt`, and `mac` commands to encrypt files.

Oracle Solaris 10 does not support ZFS encryption. However, Oracle Solaris 11 supports the following ZFS encryption features:

- ZFS encryption is integrated with the ZFS command set. Like other ZFS operations, key change and rekey operations are performed online.
- You can use your existing storage pools as long as they are upgraded. You have the flexibility of encrypting specific file systems.
- ZFS encryption is inheritable to descendent file systems. Key management can be delegated through ZFS delegated administration.
- Data is encrypted by using AES (Advanced Encryption Standard) with key lengths of 128, 192, and 256 in the CCM and GCM operation modes.
- ZFS encryption uses the Cryptographic Framework feature, which gives it access to any available hardware acceleration or optimized software implementations of the encryption algorithms automatically.

Note - Currently, you cannot encrypt a ZFS root file system or other OS components, such as the `/var` directory, even if it is a separate file system.

See "Encrypting ZFS File Systems" in *Managing ZFS File Systems in Oracle Solaris 11.3*.

Immutable Zones

The `file-mac-profile` property enables you to run zones with a read-only root file system. This feature enables you to choose between four predefined profiles that determine how much of a zone file system is read-only only, even for processes that have `allzone` privileges. See Chapter 11, “Configuring and Administering Immutable Zones” in *Creating and Using Oracle Solaris Zones*.

♦ ♦ ♦ CHAPTER 10

Managing Virtualization Features

This chapter describes the virtualization environments that are supported in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Oracle Solaris Virtualization Features

The following table provides a brief description of the various virtualization features that are supported in Oracle Solaris 11. For an introduction to virtualization in the Oracle Solaris release, see *Introduction to Oracle Solaris 11 Virtual Environments*.

TABLE 14 Virtualization Features Supported in Oracle Solaris 11

Oracle Solaris 11 Feature	Description	Oracle Solaris 10 Support	For More Information
OpenStack (Juno version)	A cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed through a dashboard that enables you to provision resources through a web interface.	Not supported	*Installing and Configuring OpenStack (Havana) in Oracle Solaris*
Oracle Solaris Resource Manager product components (also	Features that enable you to control how applications use available system resources	Supported	*Administering Resource Management in Oracle Solaris 11.3*

Oracle Solaris 11 Feature	Description	Oracle Solaris 10 Support	For More Information
referred to as resource management)			
Oracle VM Server for SPARC	Hypervisor-based virtualization for SPARC servers	Supported Starting with Oracle Solaris 11.3, running Oracle Solaris 10 in a control domain in no longer supported. However, you can continue to run Oracle Solaris 10 in guest domains.	https://www.oracle.com/technetwork/documentation/vm-sparc-194287.html
Oracle VM Server for x86 (Xen)	Hypervisor-based virtualization for x86 based servers	Supported	https://www.oracle.com/technetwork/documentation/vm-096300.html
Oracle VM VirtualBox	Hosted workstation and server virtualization for x86 based systems	Supported	https://www.oracle.com/technetwork/server-storage/virtualbox/downloads/index.html
Oracle Solaris Kernel Zones	Use the branded zones framework to run a zone with a separate kernel and OS installation from the global zone. To use kernel zones, you must be running at least Oracle Solaris 11.2.	Not supported	*Creating and Using Oracle Solaris Kernel Zones*
Oracle Solaris Zones	A virtualized operating system environment created within a single instance of the Oracle Solaris operating system	Supported	*Introduction to Oracle Solaris Zones*
Oracle VM Templates	The following types of Oracle Solaris VM templates are available: Oracle VM Templates for Oracle Solaris Zones, Oracle VM Templates for SPARC, Oracle VM Templates for x86, and Oracle VM Templates for Oracle VM VirtualBox.	Supported in some Oracle Solaris 10 releases	https://www.oracle.com/technetwork/server-storage/solaris11/downloads/virtual-machines-1355605.html

For an introduction to Oracle Solaris virtualization environments, see *Introduction to Oracle Solaris 11 Virtual Environments*.

Self-Service Computing With OpenStack

Oracle Solaris 11.3 includes the Juno version of its OpenStack distribution. The OpenStack distribution is completely integrated with several core Oracle Solaris 11 technologies, for example, Oracle Solaris Zones, ZFS, Unified Archives, as well as other software-defined networking features. With OpenStack, you can create virtual networking and compute resources by using a centralized web-based portal. To get started with OpenStack, see *Installing and Configuring OpenStack (Havana) in Oracle Solaris*.

Oracle VM Server for SPARC

Oracle VM Server for SPARC (formerly Sun Logical Domains) is the SPARC hypervisor virtualization solution for simultaneously running multiple OS instances on a single physical domain. You can use the Oracle VM Server for SPARC software on Oracle SPARC platforms to create up to 128 virtual servers, called logical domains, on a single physical domain. This kind of configuration enables you to take advantage of the massive thread scale that is offered by SPARC T-Series and SPARC M-Series servers and the Oracle Solaris OS. You can also use OS-level virtualization features, such as Oracle Solaris zones, with Oracle VM Server for SPARC.

The latest release of Oracle VM Server for SPARC includes several new virtual networking performance enhancements. For more information, go to `https://www.oracle.com/technetwork/server-storage/vm/documentation/sparc-whatsnew-330281.html`.

For complete information and instructions, see the product documentation at `https://www.oracle.com/technetwork/documentation/vm-sparc-194287.html`.

Oracle VM Server for x86

Oracle VM Server for x86 is the x86 virtualization solution that enables you to simultaneously run multiple OS instances on a single machine. Oracle VM Server for x86 is based on the open source Xen project. The Oracle VM Server for x86 software supports a privileged domain (`dom0`) to manage guest domains and unprivileged guest domains (also called `domUs`) to run workloads. As with the Oracle VM Server for SPARC control domain, the `dom0` domain permits the use of a small and efficient hypervisor and enhances availability. The Oracle VM Server for x86 software supports the running of Oracle Solaris in guest domains. Oracle Solaris guest domains can use OS-level virtualization features, such as Oracle Solaris zones.

For more information, go to `https://www.oracle.com/technetwork/documentation/vm-096300.html`.

Oracle Solaris Zones Features

The following Oracle Solaris Zones features are supported in this release. For information about the latest feature enhancements, see *Introduction to Oracle Solaris Zones*.

- **Oracle Solaris 10 branded zones** – Oracle Solaris 10 Zones provide an Oracle Solaris 10 environment on Oracle Solaris 11.

  You can migrate an Oracle Solaris 10 system or zone to a `solaris10` zone on an Oracle Solaris 11 system in the following ways:

  - Create a zone archive and use the archive to create an `s10zone` on the Oracle Solaris 11 system. See "Transitioning an Oracle Solaris 10 Instance to a Non-Global Zone on an Oracle Solaris 11 System" on page 153.
  - Detach the zone from the Oracle Solaris 10 system and attach the zone on the Oracle Solaris 11 zone. The zone is halted and detached from its current host. The `zonepath` is moved to the target host, where it is attached. See "About Detaching and Attaching the solaris10 Zone" in *Creating and Using Oracle Solaris 10 Zones*.
  - You can create and manage multiple boot environments (BEs) for a Solaris 10 branded zone, as well as modify the currently active BE or any inactive BE, all while the production workload continues to run. See "About Multiple Boot Environments On solaris10 Zones" in *Creating and Using Oracle Solaris 10 Zones*.
- **Legacy branded zones** – The following legacy branded zone features are supported in Oracle Solaris 10 only:
  - Linux brand (`lx`)
  - Oracle Solaris 8 Containers (`solaris8`)
  - Oracle Solaris 9 Containers (`solaris9`).
- **Oracle Solaris Kernel Zones** – Kernel zones, also known as `solaris-kz` branded zones, use the branded zones framework to run a zone with a separate kernel and operating system (OS) installation from the global zone. The administrative and structural content of a kernel zone is entirely independent from that of the global zone. Because kernel zones do not share system packaging with a global zone or a kernel zone host, you have complete independence over which software packages are installed on each kernel zone. Before using this feature, review the information in "Hardware and Software Requirements for Oracle Solaris Kernel Zones" in *Creating and Using Oracle Solaris Kernel Zones*.
- **Kernel zone live migration** – Oracle Solaris 11.3 supports kernel zone live migration, where the memory state of the migrated zone is copied to the migrated guest. You can use kernel zone live migration to load balance services. Live migration is recommended for situations where downtime must be minimized and when applications must remain in a running state. Live migration is only available on `solaris-kz` branded zones. See "Using Live Migration to Migrate a Kernel Zone" in *Creating and Using Oracle Solaris Kernel Zones*.

- **Oracle Solaris 11 installation support** – You can specify the configuration and installation of non-global zones as part of an AI client installation. Non-global zones are installed and configured on the first reboot after the global zone is installed. See Chapter 12, "Installing and Configuring Zones" in *Installing Oracle Solaris 11.3 Systems*.
- **Exclusive-IP zones by default** – Exclusive-IP zones enable you to assign a separate IP stack per zone. Each zone has the flexibility to configure IP within that stack completely separate to other zones. You can easily observe network traffic, per zone, and apply individual network resources. In previous versions of Oracle Solaris this was dependent on the number of physical NICs per system. The addition of network virtualization provides enhanced flexibility when managing zones, without the restrictions of physical network hardware. Newly created zones in Oracle Solaris 11 are exclusive-IP zones with a VNIC (`net0`) whose underlying link is automatically selected at boot time. See *Introduction to Oracle Solaris Zones*.
- **Immutable Zones** – The `file-mac-profile` property enables you to run a non-global zone with a read-only root file system. See Chapter 11, "Configuring and Administering Immutable Zones" in *Creating and Using Oracle Solaris Zones*.
- **IPoIb PV driver support for kernel zones** – This support is provided through the `ib-vhca` resource, which is used to specify the physical function (PF) that is used to allocate a virtual function (VF) to a kernel zone. You virtualize the PF by using the `ibadm` command, then you allocate a VF to the kernel zone by using the `zonecfg` command. For further details, see the `ibadm`(1M) and `zonecfg`(1M) man pages.
- **iSCSI support in non-global zones** – Neither iSCSI target nor initiator services are currently supported in non-global zones.
- **Network virtualization for zones** – Most Oracle Solaris network virtualization features can be applied to a zone by creating a virtual NIC (VNIC) for the zone and then applying bandwidth limits and traffic flows to the zone's assigned VNIC. The VNIC is created when the zone boots, deleted when the zone halts, and is created within the non-global zone's datalink name space. This feature enables you to provision a zone without knowing the details of the network configuration and topology. If you want to assign a preexisting datalink to an exclusive-IP zone, you can still do so during the zone configuration.
- **NFS server and CIFS support in non-global zones** – Any Oracle Solaris 11 non-global zone brand type can be an NFS server or an NFS client. However, an Oracle Solaris10 branded non-global zone cannot be an NFS server. Any Oracle Solaris 11 non-global zone can be a CIFS client, but no non-global zone of any brand type can be a CIFS server. Also, an Oracle Solaris 10 branded non-global zone cannot be a CIFS client, except when using the non-native Solaris open source Samba package.
- **Whole root zones only** – Oracle Solaris Zones are whole-root type only. However, you can configure zones in a more flexible way, for example, when disk space is limited or if you prefer a read-only zone root configuration. By default, zone boot environments are compressed.

In addition, you can automatically update any non-global zone to ensure consistency across the system. An added benefit is that individual software stacks for each non-global zone are independent of the global zone.

- **Zone monitoring** – System resources that are consumed by non-global zones can be monitored by using the `zonestat` command.

Oracle Solaris 10 Branded Zones Preparation

Prepare for migrating a Oracle Solaris 10 OS instance or zone to your Oracle Solaris 11 system as follows:

- Confirm that your Oracle Solaris 10 instance or zone is running at least the Oracle Solaris 10 9/10 release, which is the minimum OS requirement. The root file system can be UFS or ZFS.
- Confirm that your Oracle Solaris 10 instance or zone is the same platform as the system migration target. You can only migrate a SPARC instance to a SPARC system and an x86 instance to an x86 based system.
- Download and run the `/usr/sbin/zonep2vchk` script on the Oracle Solaris 10 system to determine if any issues would prevent the Oracle Solaris 10 zone or instance from running successfully on the Oracle Solaris 11 system.

  On an Oracle Solaris 10 1/13 system, the `/usr/sbin/zonep2vchk` utility is included in the release. For a system running an older Oracle Solaris 10 release, download the unbundled package from Oracle Technology Network:

  `https://www.oracle.com/technetwork/server-storage/solaris10/downloads/index.html`

  Keep in mind that this script is only for system migration purposes.
- Enable the Oracle Solaris 10 package and patch tools.

  To use the Oracle Solaris 10 package and patch tools in your Oracle Solaris 10 zones, install the following patches on your source Oracle Solaris 10 system before the image is created:

  - 119254-75, 119534-24, 140914-02 (SPARC platforms)
  - 119255-75, 119535-24 and 140915-02 (x86 platforms)

Note - The physical to virtual (P2V) process works without the patches, but the package and patch tools do not work properly within the Oracle Solaris 10 zones unless these patches are installed.

Transitioning an Oracle Solaris 10 Instance to a Non-Global Zone on an Oracle Solaris 11 System

To transition your Oracle Solaris 10 environment to a non-global zone on an Oracle Solaris 11 system, you can create a zone archive, then migrate the zone archive to the Oracle Solaris 11 system.

The steps are as follows:

1. Install the Oracle Solaris 10 zone package on your Oracle Solaris 11 system.

   ```
   s11sysB# pkg install system/zones/brand/brand-solaris10
   ```

2. Run the `zonep2vchk` script to identify any issues that might prevent the instance from running as a `solaris10` zone.

   ```
   s10sys# ./zonep2vchk
   --Executing Version: 1.0.5-11-15652

   - Source System: systema
   Solaris Version: Oracle Solaris 10 8/11 s10s_u10wos_17b SPARC
   Solaris Kernel:  5.10 Generic_147440-01
   Platform:        sun4u SUNW,Sun-Fire-V440

   - Target System:
   Solaris_Version: Solaris 10
   Zone Brand:      native (default)
   IP type:         shared

   --Executing basic checks
   .
   .
   ```

3. Create a ZFS file system that will contain the flash archive of the Oracle Solaris 10 system instance, if necessary.

   Then, create a NFS share of the ZFS file system on your Oracle Solaris 11 system.

   ```
   s11sysB# zfs create pond/s10archive
   s11sysB# zfs set share.nfs.sec.default.root=s10sysA=on pond/s10archive
   ```

4. Select an Oracle Solaris 10 instance, which could be a virtual environment or a global zone on an Oracle Solaris 10 system. Note the Oracle Solaris 10 system's `hostid`.

   ```
   s10sysA# hostid
   8439b629
   ```

5. Create an archive of the Oracle Solaris 10 instance that you plan to migrate to a non-global zone on the Oracle Solaris 11 system.

```
s10sysA# flarcreate -S -n s10sysA -L cpio /net/s11sysB/pond/s10archive/s10.flar
```

6. Create a ZFS file system for the Oracle Solaris 10 zone.

```
s11sysB# zfs create -o mountpoint=/zones pond/zones
s11sysB# chmod 700 /zones
```

7. Create the non-global zone for the Oracle Solaris 10 instance.

```
s11sysB# zonecfg -z s10zone
s10zone: No such zone configured
Use 'create' to begin configuring a new zone.
zonecfg:s10zone> create -t SYSsolaris10
zonecfg:s10zone> set zonepath=/zones/s10zone
zonecfg:s10zone> set ip-type=exclusive
zonecfg:s10zone> add anet
zonecfg:s10zone:net> set lower-link=auto
zonecfg:s10zone:net> end
zonecfg:s10zone> set hostid=8439b629
zonecfg:s10zone> verify
zonecfg:s10zone> commit
zonecfg:s10zone> exit
```

8. Install the Oracle Solaris 10 non-global zone.

```
s11sysB# zoneadm -z s10zone install -u -a /pond/s10archive/s10.flar
A ZFS file system has been created for this zone.
Progress being logged to /var/log/zones/zoneadm.20110921T135935Z.s10zone.install
Installing: This may take several minutes...
Postprocess: Updating the image to run within a zone
Postprocess: Migrating data
from: pond/zones/s10zone/rpool/ROOT/zbe-0
to: pond/zones/s10zone/rpool/export
.
.
.
```

9. Boot the Oracle Solaris 10 zone.

```
# zoneadm -z s10zone boot
```

10. Configure the Oracle Solaris 10 non-global zone.

```
s11sysB# zlogin -C s10zone
[Connected to zone 's10zone' console]
.
```

```
.
.
s10zone console login: root
Password: xxxxxxxx
# cat /etc/release
Oracle Solaris 10 8/11 s10s_u10wos_17b SPARC
Copyright (c) 1983, 2011, Oracle and/or its affiliates. All rights reserved.
Assembled 23 August 2011
# uname -a
SunOS supernova 5.10 Generic_Virtual sun4v sparc SUNW,Sun-Fire-T1000
# zfs list
NAME                 USED  AVAIL  REFER  MOUNTPOINT
rpool               4.53G  52.2G   106K  /rpool
rpool/ROOT          4.53G  52.2G    31K  legacy
rpool/ROOT/zbe-0    4.53G  52.2G  4.53G  /
rpool/export          63K  52.2G    32K  /export
rpool/export/home     31K  52.2G    31K  /export/home
```

♦ ♦ ♦ CHAPTER 11

Managing User Accounts and User Environments

This chapter provides information about the management of user accounts, groups, roles, and a user's environment in Oracle Solaris 11 releases.

For information about what's new in user account management in this Oracle Solaris 11 release, see "What's New in Managing User Accounts in Oracle Solaris 11.3" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.

The following topics are covered in this chapter:

Commands and Tools for Managing User Accounts

Note - The Solaris Management Console graphical tool and its associated command line interface have been removed. To create and manage user accounts, use the command-line and graphical tools that are described or referenced in this chapter.

TABLE 15 Commands and Tools for Managing User Accounts

Command/Tool Name	Description	For More Information
`useradd`, `groupadd`, `roleadd`	Commands for adding users, groups, and roles	"How to Add a User" in *Managing User Accounts and User Environments in Oracle Solaris 11.3* "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*

Command/Tool Name	Description	For More Information
`usermod`, `groupmod`, `rolemod`	Commands for modifying users, groups, and roles	"How to Modify a User Account" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*
`userdel`, `groupdel`, `roledel`	Commands for deleting users, groups, and roles	"How to Delete a User" in *Managing User Accounts and User Environments in Oracle Solaris 11.3* and `userdel`(1M) `groupdel`(1M), `roledel`(1M)

Managing User Accounts in Oracle Solaris

In this release, you create and manage user accounts from the command line. The User Manager GUI is also available for performing some of the tasks that you typically perform by using the command line.

The following related topics are described in more detail:

- "User Account Management Changes" on page 158
- "User Password and Login Changes" on page 160
- "Sharing Home Directories That Are Created as ZFS File Systems" on page 161
- "How Home Directories Are Mounted in Oracle Solaris" on page 162

See Chapter 3, "Managing User Accounts by Using the User Manager GUI" in *Managing User Accounts and User Environments in Oracle Solaris 11.3* for further information.

User Account Management Changes

The following features are new or have changed in this release:

- **Creating user accounts** – User account creation has changed in the following ways:
  - User accounts are created as individual ZFS file systems, which enables users to have their own file system and their own ZFS dataset. Every home directory that is created with the `useradd` and `roleadd` commands places the user's home directory on `/export/home` as an *individual* ZFS file system.
  - User names and group names can be up to 32 characters. The 8 character limitation no longer exists.
  - The `useradd` command relies on the automount service, `svc:/system/filesystem/autofs`, to mount home directories. This service should never be disabled. Each home

directory entry for a user in the `passwd` database uses the format, `/home/`*username*, which is an `autofs` trigger that is resolved by the automounter through the `auto_home` map.

- The optional server name specifies the host on which the home directory resides. Entries in this form depend on the `automounter` and are maintained in the `auto_home` map. The path `/home/`*username* is maintained in the `passwd` database. When a user subsequently references `/home/`*username*, the automounter mounts the specified directory on `/home/`*username*. You can disable the `autofs` service if you do not specify home directory path names that include a server name or `localhost`.

- **Modifying user accounts** – The `usermod` command works with LDAP and files. All security attributes can be assigned to a user by using this mechanism. For example, an administrator can add a role to a user's account by using the `usermod` command.

```
# roleadd -K roleauth=user -P "Network Management" netmgt
# usermod -R +netmgt jdoe
```

  User security attributes that are maintained in LDAP can be qualified to only apply to specific hosts or `netgroup`.

  Access to services that require authentication such as the `su`, `sudo`, or `ssh` command can be restricted to specific days and times.

  See `usermod`(1M) for additional examples.

- **Creating and managing groups** – An administrator who has the `solaris.group.manage` authorization can create a group. At group creation, the system assigns the `solaris.group.assign/`*groupname* authorization to the administrator, which gives the administrator complete control over that group. The administrator can then modify or delete that *groupname*, as needed. See the `groupadd`(1M) and `groupmod`(1M) man pages.
- **Creating and managing roles** – You can create roles locally and in an LDAP repository. To create a role and assign an initial password, you must be assigned the `User Management` rights profile. For instructions on creating a role, see "Assigning Rights to Users" in *Securing Users and Processes in Oracle Solaris 11.3*.
- **User Manager GUI** – The User Manager GUI is part of the Visual Panels project and is accessible from the desktop. The GUI replaces some of the functionality of the Solaris Management Console. See Chapter 3, "Managing User Accounts by Using the User Manager GUI" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.

User Password and Login Changes

User password management and login information have changed in the following ways:

- **Assuming a role** – All role assumption requires a password. In this release, at administrative discretion, the password that you supply to assume a role can be your own password.
- **Expanded login options during shutdown** – During a system shutdown, an `/etc/nologin` file is created. This file displays a message that the system is being shut down and that logins are not possible. However, this type of shutdown does not prevent superuser from logging into the system. In this release, users who are assigned the `root` role and users who are assigned the `solaris.system.maintenance` authorization are also not blocked when the `nologin` file is present on the system.
- **Failed login count notification** – The system notifies users of failed authentication attempts, even if the user account is not configured to enforce failed logins. Users who fail to authenticate correctly, will see a message similar to following upon successful authentication:

  ```
  Warning: 2 failed authentication attempts since last successful
  authentication. The latest at Thu May 24 12:02 2012.
  ```

  To suppress such notifications, create a `~/.hushlogin` file.
- **Monitoring and restricting `root` access** – In a default system configuration, a user cannot remotely log in to as `root`. When logging in remotely, users must log in with their user name and then become `root` by using the `su` command. You can monitor who has been using the `su` command, as well as restrict `root` access to a system. See "Monitoring and Restricting root Access" in *Securing Systems and Attached Devices in Oracle Solaris 11.3*
- **Password hashing algorithm** – The default password hashing algorithm in this release is SHA256. This password hash is similar to the following:

  ```
  $5$cgQk2iUy$AhHtVGx5Qd0.W3NCKjikb8.KhOiA4DpxsW55sP0UnYD
  ```

  Also, there is no longer an eight character limitation for user passwords. The eight character limitation only applies to passwords that use the older `crypt_unix`(5) algorithm, which has been preserved for backwards compatibility with any existing `passwd` file entries and NIS maps. Starting with Oracle Solaris 11, the `crypt_sha256` algorithm is the default

  Passwords are encoded by using one of the other `crypt`(3c) algorithms, including the SHA256 algorithm, which is the default in the `policy.conf` file. Thus, passwords can be much longer than eight characters. See `policy.conf(4)`.
- `root` **password changes** – It is no longer possible to use a system without assigning the `root` role a password of the requisite length that also meets other password complexity requirements.

- **Property definition refinements for the `password` command** – This change clarifies which user accounts can and cannot be locked. The primary changes impact the `LK` and `NL` property definitions in the following ways:

  `LK` — The account is locked for UNIX authentication. The `passwd -l` command was run, or the account was automatically locked due to the number of authentication failures reaching the configured maximum that is allowed. See the `policy.conf`(4) and `user_attr`(4) man pages.

  `NL` — The account is a `no login` account. The `passwd -N` command was run.

Sharing Home Directories That Are Created as ZFS File Systems

An NFS or a SMB share of a ZFS file system is created and then shared.

The following sharing features are provided on ZFS storage pool version 34:

- The `share.nfs` property replaces the `sharenfs` property in previous releases to define and publish an NFS share.
- The `share.smb` property replaces the `sharesmb` property in previous releases to define and publish an SMB share.
- ZFS share administration is simplified by leveraging ZFS property inheritance. If you want to share the `tank/home` file system, use syntax similar to the following:

  ```
  # zfs set share.nfs=on tank/home
  ```

  The `share.nfs` property value is inherited to any descendent file systems.

  ```
  # zfs create tank/home/userA
  # zfs create tank/home/userB
  ```

See "How to Share Home Directories That Are Created as ZFS File Systems" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.

How Home Directories Are Mounted in Oracle Solaris

Because home directories are created as ZFS file systems in Oracle Solaris 11, you typically do not need to manually mount home directories. The home directory is automatically mounted during its creation and also at boot time from the SMF local file system service. For instructions on manually mounting a user's home directory, see "Manually Mounting a User's Home Directory" in *Managing User Accounts and User Environments in Oracle Solaris 11.3*.

User Environment Feature Changes

Note the following user environment feature and command changes:

- **Addition of** `/var/user/$USER` – Starting with Oracle Solaris 11.1, whenever a user logs in and successfully authenticates by using the `pam_unix_cred` module, a `/var/user/$USER` directory is explicitly created, if the directory does not already exist. This directory enables applications to store persistent data that is associated with a particular user on the host system. The `/var/user/$USER` directory is created upon initial credential establishment, as well during a secondary authentication when changing users by using the `su`, `ssh`, `rlogin`, and `telnet` commands. The `/var/user/$USER` directory does not require any administration. However, users should be aware of how the directory is created, its function, and that it is visible in the `/var` directory.
- **Command locations** – Administration commands that were previously in `/sbin` have moved to `/usr/sbin`. In addition, the `/sbin` directory has been replaced by an `/sbin` → `/usr/sbin` symbolic link.
- **Default login and other shell changes** - In Oracle Solaris 10, the default scripting shell (`/bin/sh`) is the Bourne shell. Starting with Oracle Solaris 11, `/bin/sh` is the Korn shell (`ksh93`), and the default interactive shell is the Bourne-again (`bash`) shell. When used as a login shell, bash retrieves configuration information from the first instance of `.bash_profile`, `.bash_login`, or `.profile` file.

  Note the following additional changes:

  - The legacy Bourne shell is available as `/usr/sunos/bin/sh`.
  - The legacy `ksh88` is available as `/usr/sunos/bin/ksh` from the `shell/ksh88` package.
  - Korn shell compatibility information is available in `/usr/share/doc/ksh/COMPATIBILITY`.
- **Default user path and** `PATH` **environment variable** – The default user path is `/usr/bin`. The default path for the root role is `/usr/bin:/usr/sbin`. The default `PATH` environment variable for `bash` is `/usr/bin:/usr/sbin`

- **Developer tools locations** – Developer tools that were previously in `/usr/ccs/bin` have moved to `/usr/bin`. The `/usr/ccs/bin` directory is replaced by a `/usr/ccs/bin → /usr/bin` symbolic link.
- **Editor changes** – The `vi` family of editors, including `/usr/bin/vi`, `/usr/bin/view`, and `/usr/bin/ex`, are links to the `vim` open source implementation of the `vi` editor. The traditional SunOS versions of these commands are available in `/usr/sunos/bin/`.
- **File locations**– Files that were previously in the `/usr/sfw` directory are now in `/usr/bin`.
- **Java version** – Java 8 is the default version in this release. For more information about transitioning from Java 7 to Java 8, go to `https://www.oracle.com/technetwork/java/javase/8-compatibility-guide-2156366.html`.
- `MANPATH` **variable** – The `MANPATH` environment variable is no longer required.

  The `man` command determines the appropriate `MANPATH`, based on the `PATH` environment variable setting.

Oracle Solaris Man Page Changes

The following man page features are new or have changed:

- **Locating information in man pages** – This release has the capability of searching man pages with query strings by using the `man -K` *keywords* command. The `-K` (uppercase) option works similarly to the `-k` (lowercase) option, with the exception that the `-k` option is limited to searching only the `NAME` subsection of all of the man page sections.

  The `-k` and `-K` options uses index files for searching. The `svc:/application/man-index:default` SMF service triggers the automatic regeneration of new index files whenever new man pages are added to the `/usr/share/man` and `/usr/gnu/share/man` directories, if these directories exist. This service is enabled by default.
- **Package Name Change** – The `SUNWman` package that previously contained the Oracle Solaris man pages has changed to the smaller `system/manual` package. The bulk of the man pages are packaged separately with their component technology packages. For example, `ls.1m` for the `/usr/bin/ls` command, is part of the `system/core-os` package.
- **Man Page Display** – By default, man pages are installed on your Oracle Solaris system. If man pages on not displaying on your system, check whether the default value is set to `True` as follows:

```
$ pkg facet -a facet.doc.man
FACET VALUE SRC
facet.doc.man True system
```

  Change the setting to `True` as follows

```
$ pkg change-facet facet.doc.man=True
```

If you do not want man pages to display on your system, you can toggle the default setting to `False` as follows:

```
$ pkg change-facet facet.doc.man=False
```

Note - Changing the default setting from `True` to `False` removes all of the man pages from the system and creates a backup BE. The backup BE still has man pages, but the newly created BE does not.

♦ ♦ ♦ CHAPTER 12

Managing the Oracle Solaris 11 Desktop

This chapter describes the desktop features that are supported in Oracle Solaris 11 releases.

The following topics are covered in this chapter:

Oracle Solaris 11 Desktop Features

The default desktop environment in this release is the Oracle Solaris Desktop, which includes GNOME 2.30 from the GNOME Foundation. Also included is the Firefox Web browser, Thunderbird email client, and the Lightning calendar manager from the Mozilla Foundation.

Note - If you use the text installation method, the Oracle Solaris Desktop package (`solaris-desktop`) is not installed on your system by default. Also, the `solaris-desktop` package cannot be applied directly to a running system. See "Installing the Oracle Solaris Desktop Software Package After an Installation" on page 171.

Other supported desktop features include the following:

- Accessibility feature enhancements
- Bluefish HTML editor
- Compiz OpenGL based window manager
- D-Bus IPC Framework
- Evince PDF viewer
- GIMP image editing program
- GNOME Python bindings

- Gobby text editing collaboration tool
- Multimedia support enhancements
- Planner and `openproj` project management tools
- Trusted Extensions integration
- `xchat` IRC client
- Xserver features that augment the desktop, such as virtual terminal (VT) switching

Key Desktop Features

The following are key desktop features in this release:

- **Accessibility enhancements** – Users with disabilities can use a wide range of accessibility features, including Orca, `espeak`, and `brltty`. These features replace `gnopernicus` and provide better text-to-speech support. The Dasher on-screen keyboard also has been added in this release. For more information, see *Oracle Solaris 11 Desktop Accessibility Guide*.

  Note that the GNOME On-screen Keyboard (GOK) program that is used in Oracle Solaris 10 is no longer available. Use the Dasher application as a replacement for some users.
- **Command Assistant** – Locates command-line information in Oracle Solaris managed content, for example books and man pages. To add Command Assistant to the desktop panel, use the Add to Panel → Command Assistant dialog box. If necessary, install the package as follows:

  ```
  # pkg install cmdassist
  ```
- **Graphical login manager** – Oracle Solaris 10 uses the Common Desktop Environment (CDE) and `dtlogin` as the default login GUI. The GNOME graphical desktop manager (GDM) is also available in Oracle Solaris 10. In this release, GDM is the only graphical login option.

  The GDM configuration process has also changed considerably. To learn more, consult the `gdm` and `console-kit-daemon` man pages. ConsoleKit configuration features are used to manage multi-seat environments in this release. To troubleshoot transition issues, see "GNOME Desktop Manager Issues" on page 171.
- **Multimedia support:**
  - **Brasero CD/DVD burner** – You can use the Brasero CD/DVD burner to create a data disc project, drag and drop files in place, and then burn them.
  - **FreeDesktop GStreamer** – The FreeDesktop GStreamer module is a desktop tool that provides multimedia support. GStreamer uses a plug-in infrastructure that enables the use of additional media formats.
  - `gksu` – Is the graphical version of the `sudo` command. When launched, the tool displays a prompt that enables you to type an additional password to run an administrative tool.

- **Multimedia formats** – The FLAC, Speex, Ogg Vorbis, and Theora media formats are supported through the use of GStreamer plugins. Oracle Solaris 11 provides GStreamer 0.10, while Oracle Solaris 10 uses GStreamer 0.8.
- **Open Sound System** – The Open Sound System (OSS) framework manages audio devices and provides better audio support. Some audio devices that were previously supported are no longer supported. Programs that use the Sun Audio Device Architecture (SADA) interfaces continue to be supported. If your audio device is not working properly, you can launch a dialog box from the desktop that enables you to choose which audio device and GStreamer audio input/output plugins to use:

  ```
  $ /usr/bin/gstreamer-properties
  ```

  This program also includes a Test button that enables you to determine whether your audio settings are correct. Note that some audio cards present themselves as having more than one device, for example, one for analog audio and one for digital audio. If you are currently using RealPlayer, you will need to transition to the multimedia tools that are currently supported.
- **PulseAudio sound server** – The PulseAudio sound server supports improved audio mixing. The `/usr/bin/gnome-volume-control` Device combo-box displays additional PulseAudio devices. For desktop and notebook PC use, the "OSS" device choice should work best. To determine the best setting for your audio hardware, some initial trial-and-error might be required. If you continue to experience audio problems, run the following command to verify that the correct default Input/Output audio plug-ins are selected:

  ```
  $ /usr/bin/gstreamer-properties
  ```

  PulseAudio additionally provides CLI configuration capabilities: `$HOME/.pulse`, and `$HOME/.pulse-cookie`. See `pulseaudio`(1) for details. On systems with a working audio card, you will notice that the `/usr/bin/pulseaudio` process is running for GNOME sessions. Go to `https://www.freedesktop.org/wiki/Software/PulseAudio/`.
- **Other media tools** – Rhythmbox media player, Cheese photo/video tool, the Ekiga video conference tool are also included in this release.

- **Network administration GUI** – You use the network administration GUI (formerly NWAM) to manage network connections from the desktop. See "Administering Network Configuration From the Desktop" in *Configuring and Managing Network Components in Oracle Solaris 11.3*.
- **Print management** – Starting with Oracle Solaris 11, CUPS is the default print service, replacing the LP print service that is used in Oracle Solaris 10. Solaris Print Manager is also no longer available in the desktop. CUPS has a print manager that you can start from the desktop by choosing System → Administration → Print Manager. See *Configuring and Managing Printing in Oracle Solaris 11.3*.
- **Removable media** – Oracle Solaris 11 includes various removable media enhancements, including support for hot-pluggable device discovery, content recognition, usability,

security, and performance across all layers of the software stack, from device drivers to the GUI. You can use the Eject button on a CD/DVD drive's front panel to eject a disc, even if it is mounted. The Nautilus file manager automatically registers when external hard drives or flash cards are inserted.

The functions of the `vold` daemon and the `volcheck` command are performed by the Hardware Abstraction Layer (HAL) through the `rmvolmgr` and `gvfs-hal-volume-monitor` commands, which are HAL-aware. See `rmvolmgr(1M)`.

- **Seahorse** – GnuPG is supported in this release. The Seahorse application manages encryption keys and passwords in the `gnome-keyring`. Seahorse also replaces the `gnome-keyring-manager` for managing SSH and GnuPG keys.
- **Trusted Extensions (GNOME) desktop** – In this release, the Trusted Extensions feature of Oracle Solaris is supported *only* in the Oracle Solaris Desktop (GNOME 2.30). In Oracle Solaris 10, this feature is supported in both CDE and the GNOME Desktop. In Solaris 8, this support is limited to CDE.

  This version of the Trusted Extensions desktop includes significant changes that improve usability, robustness, and functionality, which also includes zones and rights profile improvements. For example, the `txzonemgr` GUI has significantly improved. You can use this tool to manage most aspects of Trusted Extensions. If you are currently using Trusted CDE, you will need to migrate to the a currently supported version of the product.
- **Time Slider** – Manages ZFS snapshots. Use the tool to regularly back up data by taking timed ZFS snapshots.
- **Virtual console terminals**– You can switch between an X session and a virtual console terminal. This service is enabled by default. To switch between sessions, use the **Alt** + **Ctrl** + **F#** hotkey combination. For example, to switch to `vt2`, press **Alt** + **Ctrl** + **F2**. Also, you can create graphical VT sessions and then switch between those sessions by using the User Switcher panel applet. To add the applet to the desktop, right click the panel, then select the Add to Panel... option. To switch to a new or different graphical login session, click the applet, then select Switch User.
- **Web browser and email** – Firefox Web browser and Thunderbird email client are the supported applications.

Desktop Features That Have Been Removed

The following desktop features have been replaced or removed. Note that some removed features were introduced later than Oracle Solaris 10:

- Adobe Flash Player – This feature was present in Oracle Solaris 11 11/11, but removed in Oracle Solaris 11.1. You can download older versions from Adobe's web site, but Adobe no longer produces or supports Flash for Oracle Solaris.

- Common Desktop Environment (CDE) – CDE is replaced by the Oracle Solaris Desktop (GNOME 2.30).
- ESounD – Migrate to the GStreamer programs, such as `gst-launch`.
- `gnome-keyring-manager` – Seahorse replaces this feature.
- GNOME On-screen Keyboard (GOK) program – You can use the Dasher application as a replacement in some instances.
- GNOME System tools (Introduced in a previous Oracle Solaris 11 release):
  - `network-admin` – NWAM replaces this feature. This tool is now called the Network Administration GUI.
  - `shares-admin` – Use the `/usr/bin/vp sharemgr` command.
  - `time-admin` – Use the `/usr/bin/vp time` command.
  - `users-admin` (GNOME Users and Groups tool) – No replacement is currently available. See "Commands and Tools for Managing User Accounts" on page 157.

  The GNOME System tools are not available in Oracle Solaris 10.
- Solaris Management Console – This tool and its equivalent command-line are no longer available. The User Manager GUI replaces this tool, starting with Oracle Solaris 11.1. See "Commands and Tools for Managing User Accounts" on page 157.
- Solaris Print Manager – This tool is replaced by CUPS Print Manager. See "Printer Configuration and Management Changes" on page 130.
- `Xsun` family of servers – The `Xorg` family of servers is still supported. See "Xorg Family of Servers" on page 169.

Graphics Driver Changes

Starting with Oracle Solaris 11.3, the NVIDIA graphics driver in the `driver/graphics/nvidia` package has been updated to version 346.35. This driver only supports the Fermi, Kepler, and Maxwell family of graphics processing units (GPUs). Older GPUs that work with the 340 driver will now fall back to the `vesa/vgatext` drivers. Note that older GPUs continue to be supported, but the support has transitioned to the 340 legacy driver. If you know your GPU by name, you can find a full list of affected GPUs at `https://nvidia.custhelp.com/app/answers/detail/a_id/3473`.

Xorg Family of Servers

While Oracle Solaris 10 includes both the `Xsun` family of X servers, with `Xsun` as the default on SPARC platforms, and `Xorg` as the default on x86 platforms, Oracle Solaris 11 only supports

the Xorg family of servers. As a result, X programs have moved from /usr/X11/bin to /usr/bin. Note that Xorg software packages are included with the Live Media, but not with the interactive text installer. The following table lists legacy Oracle Solaris X server commands and the corresponding Oracle Solaris 11 commands.

TABLE 16 Oracle Solaris 11 X Server Commands

Legacy Command	Oracle Solaris 11 Command
/usr/openwin/bin/Xsun	/usr/bin/Xorg See Xorg(1)
/usr/openwin/bin/Xnest	/usr/bin/Xephyr See Xephyr(1)
/usr/openwin/bin/Xvfb	/usr/bin/Xvfb See Xvfb(1)

▼ How to Update Custom Hot Key Configurations or Enable Legacy Mappings

Oracle Solaris 11 has moved to more common Xorg key mappings. For example, the **Copy** key is mapped to XF86Copy.

1. **To update custom hot key configurations or enable the legacy mappings from the desktop, open the Keyboard panel from the System → Preferences menu.**
2. **Select the Layouts tab, then click the Options... button to open the Keyboard Layout Options dialog box.**
3. **Select the Maintain key compatibility with old Solaris keycodes option, then select the Sun Key Compatibility checkbox.**

Troubleshooting Desktop Transition Issues

Refer to the following troubleshooting information when transitioning to the Oracle Solaris Desktop (GNOME 2.30):

- “Installing the Oracle Solaris Desktop Software Package After an Installation” on page 171

- "GNOME Desktop Manager Issues" on page 171

Installing the Oracle Solaris Desktop Software Package After an Installation

The Oracle Solaris 11 text installer does not include the primary software package that includes the GNOME 2.30 desktop. If you use this installation method, you will need to install the `solaris-desktop` package afterwards. For information about using the `pkg install` command to add packages after a text installation, see "Adding Software After a Text Installation" in *Installing Oracle Solaris 11.3 Systems*.

GNOME Desktop Manager Issues

Note the following potential GDM login issues:

- **CDE to GDM login configuration** – If you customized your CDE login in Oracle Solaris 10, you will likely need to reintegrate your configuration choices to work with GDM in Oracle Solaris 11. Note that an exact one-to-one mapping between CDE and GDM login features does not exist. Some CDE login configuration choices are not available in the GDM login, and there are some GDM login configuration choices that are not available in the CDE login. For example, the GDM login screen does not offer a chooser screen by default.

  Another example is the X Display Manager Control Protocol (XDMCP) feature, which is configured and enabled differently in Oracle Solaris 11 than in Oracle Solaris 10. The GDM provides the ability to run an XDMCP server, but this feature is disabled by default. You can enable the feature by modifying the GDM configuration file.

  Another requirement of XDMCP is that X11 allow TCP/IP connections, which is also disabled by default. Refer to the `Xserver`(1) man page for instructions on how to enable this feature. See also the `gdm`(1) man page, the yelp-tools manual, and the online help.
- **Support for Oracle Solaris 10 GDM themes in Oracle Solaris** – In Oracle Solaris 10, GDM is shipped as a non-default login program, which includes a GUI configuration tool. In Oracle Solaris 11, GDM does *not* have this GUI configuration tool. Also, the GDM *themes* that work with GDM in Oracle Solaris 10 are not supported in this release. You can change the appearance of the GDM login GUI by modifying the `/usr/share/gdm/gdm-greeter-login-window.ui` file, as desired.