

Managing Devices in Oracle® Solaris 11.4

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Managing Devices in Oracle Solaris 11.4

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Using This Documentation

- **Overview** – Describes how to manage removable media, disks, and devices.
- **Audience** – System administrators.
- **Required knowledge** – Basic Oracle Solaris or UNIX system administration experience.

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◆◆◆ CHAPTER 1

Managing Devices in Oracle Solaris

This chapter provides overview information about device management in Oracle Solaris. Oracle Solaris supports various peripheral devices such as disks, DVD drives, and tape devices.

This chapter covers the following topics:

- “About Devices and the Oracle Hardware Management Pack” on page 17
- “About Device Management” on page 17
- “Adding a Peripheral Device to a System” on page 28
- “Accessing Devices” on page 30
- “Where to Find Additional Device Management Tasks” on page 34

About Devices and the Oracle Hardware Management Pack

Oracle Hardware Management Pack features provide cross-platform components to better manage your hardware such as displaying hardware configuration and status information. These features are included in the `system/management` package with names similar to the following examples:

```
system/management/fwupdate
system/management/ipmitool
system/management/raidconfig
system/management/ubiosconfig
```

For more information about these features, go to [Systems Management and Diagnostics Documentation Library \(https://docs.oracle.com/cd/F24624_01/index.html#hwmgmt\)](https://docs.oracle.com/cd/F24624_01/index.html#hwmgmt).

About Device Management

Device management in the Oracle Solaris can involve tasks such as the following:

- Adding and removing peripheral devices from systems

- Adding a third-party device driver to support a device
- Displaying system configuration information.

Note - If you are using an x86 based system, use the device detection tool to determine if the hardware is supported in this Oracle Solaris release. For more information, go to [Device Support on Oracle Solaris \(https://www.oracle.com/webfolder/technetwork/hcl/devicelist/index.html\)](https://www.oracle.com/webfolder/technetwork/hcl/devicelist/index.html).

About Device Drivers

A computer uses a wide range of peripheral devices and mass-storage devices such as drives, printers, and so on. The Oracle Solaris software does not directly communicate with all of these devices. Each type of device requires different data formats, protocols, and transmission rates.

A *device driver* is a low-level program that enables the operating system to communicate with a specific piece of hardware. The driver serves as the operating system's "interpreter" for that piece of hardware.

You can customize a driver configuration by adding or modifying either a per-device parameter or a global property in that driver's configuration file. The addition or modification affects all devices in the system. In the Oracle Solaris 11.4 release, driver customizations are made in the `/etc/driver/drv` directory rather than in the `/kernel` directory as in previous releases. Files in the `/etc/driver/drv` directory are preserved during the upgrade. Thus, your driver customizations are not overwritten when the system is upgraded.

▼ How to Customize a Driver Configuration

1. **Become an administrator.**
2. **Copy the original vendor-supplied `driver.conf` file to the `/etc/driver/drv` directory. For example:**

```
# cp /kernel/drv/sd.conf /etc/driver/drv/sd.conf
```

3. **Modify the parameter entry and save the file.**

For example, the `sd.conf` file includes the following entry for the SCSI (pronounced "scuzzy") `sd` device at target 0, lun 0:

```
name="sd" class="scsi" target=0 lun=0;
```

To add the `retries` parameter for this device, modify the existing entry as follows:

```
name="sd" class="scsi" target=0 lun=0 retries=4;
```

4. Display the customized property value.

For example:

```
# prtconf -vu
sd, instance #1
Admin properties:
name='retries' type=int items=1
value=00000004
```

Automatic Configuration of Devices

The kernel consists of a small generic core with a platform-specific component and a set of modules. A *kernel module* is a software component that performs a specific task on the system. A device driver that is loaded when the device is accessed is an example of a *loadable* kernel module.

The following lists the location and contents of the Oracle Solaris kernel modules:

```
/platform/arch/kernel
```

Platform-specific kernel components.

arch is the information that is displayed by the `uname -m` command.

```
/kernel
```

Kernel components common to all platforms that are needed for booting the system

```
/usr/kernel
```

Kernel components common to all platforms within a particular instruction set

The system determines the devices that are attached to it at boot time. Then, the kernel configures itself dynamically, loading needed modules into memory, a process called *autoconfiguration*. At this time, device drivers are loaded when devices such as disk devices and tape devices are accessed.

Autconfiguration provides the following benefits:

- Main memory is used more efficiently because modules are loaded when needed.
- Kernel reconfiguration is unnecessary when new devices are added to the system.
- You can load and test drivers without having to rebuild the kernel.

- You can add a new device and its driver without having to perform a reconfiguration boot afterwards.

You can add, remove, or replace devices in Oracle Solaris while the system is still running provided that the system components support hot-plugging. For information about hot-plugging devices, see [Chapter 2, “Dynamically Configuring Devices”](#).

You can also customize the way in which kernel modules are loaded by modifying the `/etc/system` file. For instructions, see the [system\(5\)](#) man page.

Installing Unsupported Devices

Oracle Solaris provides device drivers that support a wide range of standard devices in the `/kernel/drv` and `/platform/`uname -m`/kernel/drv` directories.

For an unsupported device, the manufacturer should provide the necessary software to properly install, maintain, and administer the device. At a minimum, this software consists of the following:

- Device driver
- Associated configuration file that will reside in the `/kernel/drv` directories
- Custom maintenance and administrative utilities in case the device is incompatible with Oracle Solaris utilities

For more information about what you need for unsupported devices, contact your device manufacturer.

Displaying Device Configuration Information

The following commands display system and device configuration information:

<code>prtconf</code>	Displays system configuration information, including the total amount of memory and the device configuration, as described by the system's device hierarchy. The output that is displayed by this command depends upon the type of system. For more information, see the prtconf(8) man page.
<code>sysdef</code>	Displays device configuration information, including system hardware, pseudo devices, loadable modules, and selected kernel parameters. For more information, see the sysdef(8) man page.

`dmesg` Displays system diagnostic messages as well as a list of the devices that were attached to the system since the last reboot. For more information, see the `dmesg(8)` man page.

For information about the device names that are used to identify devices on the system, see [“Device Naming Conventions” on page 31](#).

When you run the `prtconf` and `sysdef` commands, the output might include the following driver-related message line next to specific device instances:

```
device, instance #number (driver not attached)
```

The absence of a driver can occur due to one of the following reasons:

- A driver is unavailable for the device.
- No driver is currently attached because the device is not in use. When a device is unused, its driver is automatically unloaded.
- No driver is currently attached because the device itself does not exist at that device instance.

Because system processes always monitor system devices, the message usually indicates the absence of the device.

The following utilities detect when a specified device is in use:

- `dumpadm`
- `format`
- `mkfs` and `newfs`
- `swap`

These utilities might detect some of the following usage scenarios:

- Device is part of a ZFS storage pool
- Device is a dump or swap device
- Mounted file system or an entry for the device exists in the `/etc/vfstab` file

For example, using the `format` utility to access an active device might generate a message similar to the following example:

```
# 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
Specify disk (enter its number): 0
selecting clt0d0
[disk formatted]
/dev/dsk/clt0d0s0 is part of active ZFS pool rpool. Please see zpool(8).
```

FORMAT MENU:

```
.
```

The following examples show how to use the `prtconf`, `sysdef`, and other commands to display system configuration information.

EXAMPLE 1 Displaying All the Devices of a SPARC Based System

```
$ /usr/sbin/prtconf -v | more
System Configuration: Oracle Corporation sun4v
Memory size: 30720 Megabytes
System Peripherals (Software Nodes):

ORCL,SPARC-T4-2
  Driver properties:
    name='pm-hardware-state' type=string items=1 dev=none
    value='no-suspend-resume'
    name='fm-errcb-capable' type=boolean dev=none
    name='fm-ereport-capable' type=boolean dev=none
  System properties:
    name='root-be-uuid' type=string items=1
    value='3e8a2870-cb04-4610-821c-c2da8e0c8050'
    name='root-uuid-chk' type=string items=1
    value='1'
    name='stdout-#lines' type=int items=1
    value=ffffffff
    name='stdin' type=int items=1
    value=fecbfe48
    name='stdout' type=int items=1
    value=fecbf6e0
    name='memory' type=int items=1
    value=fff04290
    name='mmu' type=int items=1
    value=fff04080
    name='bootpath' type=string items=1
    value='/virtual-devices@100/channel-devices@200/disk@0:a'
    name='bootargs' type=string items=1
```

```

        value=''
name='bootfs' type=int items=1
        value=feedbd88
name='zfs-bootfs' type=string items=1
        value='rpool/240'
name='bootarchive' type=string items=1
        value='/ramdisk-root

```

EXAMPLE 2 Displaying Information About a Specific Device of a SPARC Based System

In this example, the sd instance number for /dev/dsk/c4t2d0s0 is displayed.

```

# prtconf -v /dev/dsk/c4t2d0s0 | grep instance
sd, instance #5

```

EXAMPLE 3 Displaying Only the Devices That Are Attached to the System

```

# prtconf | grep -v not

```

EXAMPLE 4 Displaying Device Usage Information

In this example, the fuser command is used to display which processes are accessing the /dev/console device.

```

# fuser -d /dev/console
/dev/console:      5742o    2269o    20322o    858o

```

EXAMPLE 5 Displaying System Configuration Information of an x86 Based System

```

# prtconf
System Configuration: Oracle Corporation i86pc
Memory size: 8192 Megabytes
System Peripherals (Software Nodes):

```

```

i86pc
scsi_vhci, instance #0
pci, instance #0
pci108e,4843, instance #0
pci8086,25e2, instance #0
pci8086,3500, instance #7
pci8086,3510, instance #9
pci8086,3518, instance #10
pci108e,4843, instance #0
pci108e,4843, instance #1
pci8086,350c, instance #8

```

```
pci8086,25e3 (driver not attached)
pci8086,25f8, instance #2
pci108e,286, instance #0
disk, instance #0
disk, instance #2
disk, instance #3
disk, instance #1
pci8086,25e5 (driver not attached)
pci8086,25f9 (driver not attached)
pci8086,25e7 (driver not attached)
pci108e,4843, instance #0 (driver not attached)
pci108e,4843, instance #1
pci108e,4843, instance #2 (driver not attached)
pci108e,4843 (driver not attached)
pci108e,4843 (driver not attached)
pci108e,4843 (driver not attached)
pci108e,4843 (driver not attached)
pci8086,2690, instance #6
pci108e,125e, instance #2
pci108e,125e, instance #3
pci108e,4843, instance #0
pci108e,4843, instance #1
device, instance #0
keyboard, instance #0
mouse, instance #1
pci108e,4843, instance #2
pci108e,4843, instance #3
pci108e,4843, instance #0
storage, instance #0
disk, instance #4
.
.
.
```

EXAMPLE 6 Displaying Device Configuration Information of an x86 Based System

```
# sysdef
* Hostid
*
29f10b4d
*
* i86pc Configuration
*
*
* Devices
*
+boot (driver not attached)
```

```

memory (driver not attached)
aliases (driver not attached)
chosen (driver not attached)
i86pc-memory (driver not attached)
i86pc-mmu (driver not attached)
openprom (driver not attached)
options, instance #0
packages (driver not attached)
delayed-writes (driver not attached)
isa, instance #0
motherboard (driver not attached)
pnpADP,1542, instance #0
asy, instance #0
asy, instance #1
lp, instance #0 (driver not attached)
fdc, instance #0
fd, instance #0
fd, instance #1 (driver not attached)
kd (driver not attached)
kdmouse (driver not attached)
.
.
.

```

Resolving Faulty Devices

A device retirement mechanism isolates a device that is flagged as *faulty* by the fault management framework (FMA). This feature enables faulty devices to be safely and automatically inactivated to avoid data loss, data corruption, or panics and system down time. The retirement process takes into account the stability of the system after the device has been retired.

Critical devices are never retired. If you need to manually replace a retired device, use the `fmadm repair` command after the device replacement to notify the system that the device is replaced.

For more information, see the [fmadm\(8\)](#) man page.

When a device is retired, a message similar to the following example is displayed on the console and recorded in the `/var/adm/messages` file.

```

Aug 9 18:14 starbug genunix: [ID 751201 kern.notice] \
    NOTICE: One or more I/O devices have been retired

```

You can use the `prtconf` command to identify specific retired devices. For example:

```
# prtconf
.
.
.
pci, instance #2
scsi, instance #0
disk (driver not attached)
tape (driver not attached)
sd, instance #3
sd, instance #0 (retired)
scsi, instance #1 (retired)
disk (retired)
tape (retired)
pci, instance #3
network, instance #2 (driver not attached)
network, instance #3 (driver not attached)
os-io (driver not attached)
iscsi, instance #0
pseudo, instance #0
.
.
.
```

▼ How to Resolve a Faulty Device

This procedure describes how to resolve a faulty device or a device that has been retired.

Note - For ZFS device problem or failure information, see [Chapter 11, “Oracle Solaris ZFS Troubleshooting and Pool Recovery”](#) in *Managing ZFS File Systems in Oracle Solaris 11.4*.

1. Identify the faulty device with the `fmadm faulty` command.

For example:

```
# fmadm faulty
-----
TIME                EVENT-ID                MSG-ID SEVERITY
-----
Jun 20 16:30:52 55c82fff-b709-62f5-b66e-b4e1bbe9dcb1 ZFS-8000-LR Major

Problem Status      : solved
Diag Engine         : zfs-diagnosis / 1.0
System
Manufacturer       : unknown
Name                : ORCL,SPARC-T3-4
Part_Number        : unknown
```

```
Serial_Number : 1120BDRCCD
Host_ID       : 84a02d28
```

```
-----
Suspect 1 of 1 :
Fault class   : fault.fs.zfs.open_failed
Certainty    : 100%
Affects      : zfs://pool=86124fa573cad84e/vdev=25d36cd46e0a7f49/
pool_name=pond/vdev_name=id1,sd@n5000c500335dc60f/a
Status       : faulted and taken out of service
```

```
FRU
Name         : "zfs://pool=86124fa573cad84e/vdev=25d36cd46e0a7f49/
pool_name=pond/vdev_name=id1,sd@n5000c500335dc60f/a"
Status      : faulty
```

Description : ZFS device 'id1,sd@n5000c500335dc60f/a' in pool 'pond' failed to open.

Response : An attempt will be made to activate a hot spare if available.

Impact : Fault tolerance of the pool may be compromised.

Action : Use 'fmadm faulty' to provide a more detailed view of this event. Run 'zpool status -lx' for more information. Please refer to the associated reference document at <http://support.oracle.com/msg/ZFS-8000-LR> for the latest service procedures and policies regarding this diagnosis.

2. Replace the faulty or retired device or clear the device error.

For example:

```
# zpool clear pond c0t5000C500335DC60Fd0
```

If an intermittent device error occurred but the device was not replaced, you can attempt to clear the previous error, which is the faulty device identified by fmadm utility.

3. Clear the FMA fault.

For example:

```
# fmadm repaired zfs://pool=86124fa573cad84e/vdev=25d36cd46e0a7f49/ \
pool_name=pond/vdev_name=id1,sd@n5000c500335dc60f/a
fmadm: recorded repair to of zfs://pool=86124fa573cad84e/vdev=25d36cd46e0a7f49/
pool_name=pond/vdev_name=id1,sd@n5000c500335dc60f/a
```

4. Confirm that the fault is cleared.

```
# fmadm faulty
```

If the error is cleared, the `fmadm faulty` command does not return any output.

Adding a Peripheral Device to a System

To add a new peripheral device that is not hot-pluggable, you perform the following general steps:

- Shut down the system
- Connect the device to the system
- Reboot the system

In some cases, you might also have to add a third-party device driver to support the new device.

For information about hot-plugging devices, see [Chapter 2, “Dynamically Configuring Devices”](#).

This section describes how to add peripheral devices and device drivers.

▼ How to Add a Peripheral Device

This procedure applies to the following devices that are not hot-pluggable:

- DVD drive
- Secondary disk drive
- Tape drive

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. (Optional) If you need to add a device driver to support the device, complete the procedure [“How to Add a Device Driver”](#) on page 29.

3. Shut down the system.

```
# shutdown -i0 -g30 -y
```

`-i0` Brings the system to the 0 init state, which is the appropriate state for turning the system power off for adding and removing devices.

- g30 Shuts the system down in 30 seconds. The default is 60 seconds.
- y Continues the system shutdown without user intervention. Otherwise, you are prompted to continue the shutdown process.

4. Turn off power to the system after it is shut down.

- For SPARC platforms, turn off power when the ok prompt is displayed.
- For x86 platforms, turn off power when the type any key to continue prompt is displayed.

5. Turn off power to all peripheral devices.

If you are not sure where the power switch is located on a peripheral device, refer to the device manufacturer's installation guide.

6. Install the peripheral device, making sure that the hardware configuration adheres to manufacturer specifications.

Refer to the hardware installation guide that accompanies the peripheral device for information about installing and connecting the device.

7. Turn on the power to the system.

The system boots to multiuser mode and the login prompt is displayed.

8. To verify that the peripheral device has been added, access the device.

For more information, see [“Accessing Devices” on page 30](#).

▼ How to Add a Device Driver

In the Oracle Solaris 11.4 release, you use the `pkg` commands to add packages to the system. However, because device driver packages might still be in SVR4 (System V Release 4) package format, this procedure uses the `pkgadd` command instead of the `pkg install` command.

Before You Begin This procedure assumes that the device has already been added to the system. If not, see [“How to Add a Peripheral Device” on page 28](#).

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Place the media into the drive or download it.

3. Install the driver.

```
# pkgadd [-d] device package-name
```

4. Verify that the package has been added correctly.

```
# pkgchk package-name
#
```

If the package is correctly installed, the command does not return any output.

Example 7 Adding a Device Driver

This example shows how to install and verify a package called XYZdrv.

```
# pkgadd XYZdrv
(licensing messages displayed)
.
.
.
Installing XYZ Company driver as <XYZdrv>
.
.
.
Installation of <XYZdrv> was successful.
# pkgchk XYZdrv
#
```

Accessing Devices

To manage disks, file systems, and other devices, you must know how to specify device names. In most cases, you can use logical device names to represent devices that are connected to the system. Both logical and physical device names are represented on the system by logical and physical device files.

How Device Information Is Created

When a system is booted for the first time, a device hierarchy is created to represent all the devices connected to the system. The kernel uses the device hierarchy information to associate drivers with their appropriate devices. The kernel also provides a set of pointers to the drivers that perform specific operations.

The device hierarchy consists of the following directories:

- `/devices` – The name space of all devices on the system. This directory represents the *physical* devices that consists of actual bus and device addresses. The `devfs` file system manages this directory.
- `/dev` – The name space of *logical* device names. The `dev` file system manages this directory.

The `devfsadm` command manages system devices by performing the following operations:

- It attempts to load every driver in the system and attach the drivers to all possible device instances.
- It creates the device files in the `/devices` directory and the logical links in the `/dev` directory.
- It maintains the `path_to_inst` instance database.

The `devfsadm` daemon automatically updates the `/dev` and `/devices` directories in response to dynamic reconfiguration events or file system accesses. This daemon is started by the service management facility when a system is booted.

For more information, see the following references:

- [devfsadm\(8\)](#)
- [dev\(4FS\)](#)
- [devfs\(4FS\)](#)
- [path_to_inst\(5\)](#)

Device Naming Conventions

In Oracle Solaris, devices are referenced in one of three ways:

- **Physical device name** – Represents the full device path name in the device information hierarchy. The physical device name is created by when the device is first added to the system. Physical device files are found in the `/devices` directory.
- **Instance name** – Represents the kernel's abbreviation name for every possible device on the system. For example, `sd0` and `sd1` represent the instance names of two disk devices. Instance names are mapped in the `/etc/path_to_inst` file.
- **Logical device name** – The logical device name is created when the device is first added to the system. You use logical device names with most file system commands to refer to devices. Logical device files in the `/dev` directory are symbolically linked to physical device files in the `/devices` directory.

The following commands display device name information:

- `dmesg`

- format
- sysdef
- prtconf

Logical Disk Device Names

You use logical device names to access disk devices when you perform the following tasks:

- Add a new disk to the system.
- Move a disk from one system to another system.
- Access or mount a file system residing on a local disk.
- Back up a local file system.

Names of logical devices use the format `/dev/[r]dsk/cntndn[sn,pn]`.

<code>dev</code>	Devices directory.
<code>[r]dsk</code>	Disk device subdirectory (see “Disk Subdirectory” on page 32 for more information)
<code>cn</code>	Logical controller number
<code>tn</code>	Physical bus target number
<code>dn</code>	Drive number
<code>[sn,pn]</code>	Slice number (s0 to s7) or fdisk partition number (p0 to p4).

For information about specifying disk partitions or slices, see [“Direct and Bus-Oriented Controllers” on page 33](#).

Disk Subdirectory

Some disk and file administration commands require the use of either a *raw* (or *character*) device interface or a *block* device interface. Raw device interfaces transfer only small amounts of data at a time. Block device interfaces include a buffer from which large blocks of data are read at once.

The disk subdirectory you specify depends on the device interface required by the command.

- When a command requires the raw device interface, specify the `/dev/rdisk` subdirectory. (The "r" in `rdisk` stands for "raw".)
For example: `prtvtoc /dev/rdisk/c0t0d0s0`
- When a command requires the block device interface, specify the `/dev/dsk` subdirectory.
For example: `dumpadm -d /dev/zvol/dsk/rpool/dump`

If you are not sure whether a command requires use of `/dev/dsk` or `/dev/rdisk`, check the man page for that command.

Direct and Bus-Oriented Controllers

You access disk partitions or slices differently depending upon whether the disk device is connected to a direct or bus-oriented controller. Generally, direct controllers do not include a *target* identifier in the logical device name.

Note - Controller numbers are assigned automatically during system initialization. The numbers are strictly logical and imply no direct mapping to physical controllers.

Both direct and bus-oriented controller names use the following conventions:

<i>cn</i>	Logical controller number
<i>dn</i>	Drive number
<i>[sn, pn]</i>	Slice number (<i>s0</i> to <i>s7</i>) or <i>fdisk</i> partition number (<i>p0</i> to <i>p4</i>)

- To specify a slice on a disk with an IDE controller, use the naming convention `cdn[sn, pn]`.
To indicate the entire *fdisk* partition, specify slice 2 (*s2*).
- To specify a slice on a disk with a bus-oriented controller, SCSI for example, you would add the physical bus target number (*tn*): `cntndn[sn, pn]`.
To indicate the whole disk, specify slice 2 (*s2*).

Logical Tape Device Names

Logical tape device files are listed in the `/dev/rmt/*` directory as symbolic links from the `/devices` directory. The naming convention is `/dev/rmt/nd`.

<code>dev</code>	Devices directory
<code>rmt</code>	Raw magnetic tape device directory
<code>n</code>	Drive number (0-)
<code>d</code>	Optional density, which can be l (low), m (medium), h (high), u (ultra), or c (compressed).

The first tape device connected to the system is 0 (`/dev/rmt/0`). For information about tape density values, see [Chapter 10, “Managing Tape Drives Tasks”](#).

Logical Removable Media Device Names

Because removable media is managed by removable media management services, the logical device name is usually not used unless you want to mount the media manually.

For information about the logical device names that represent the removable media devices on a system, see [“Accessing Removable Media” on page 248](#).

Where to Find Additional Device Management Tasks

You can find step-by-step instructions for hot-plugging devices and adding serial devices, such as printers and modems, in the following guides:

- Add a disk that is not hot-pluggable – [Chapter 7, “Setting Up ZFS on Disks”](#) or [“Setting Up Disks for ZFS File Systems” on page 141](#)
- Hot-plug a SCSI or PCI device – [“Performing SCSI Hot-Plugging Operations” on page 37](#) or [“PCI or PCIe Hot-Plugging With the `cfgadm` Command” on page 47](#)
- Hot-plug a USB device – [“Managing USB Mass Storage Devices” on page 214](#)
- Add terminal services – [Chapter 5, “Managing the System Console, Terminal Devices, and Power Services” in *Managing System Information, Processes, and Performance in Oracle Solaris 11.4*](#)
- Add a printer – [Configuring and Managing Printing in Oracle Solaris 11.4](#)
- Secure a device – [Securing Systems and Attached Devices in Oracle Solaris 11.4](#)

Dynamically Configuring Devices

This chapter describes dynamic reconfiguration (DR) in Oracle Solaris and provides instructions for performing DR operations on SPARC based or x86 based systems. It covers the following topics:

- [“Dynamic Reconfiguration and Hot-Plugging” on page 35](#)
- [“Performing SCSI Hot-Plugging Operations” on page 37](#)
- [“PCI or PCIe Hot-Plugging With the `cfgadm` Command” on page 47](#)
- [“Performing SATA Hot-Plugging Operations” on page 59](#)
- [“Reconfiguration Coordination Manager \(RCM\) Script Overview” on page 61](#)
- [“Using RCM Scripts” on page 63](#)

For information about hot-plugging other device types, see the following chapters or sections:

- USB devices – [“Hot-Plugging USB Devices With the `cfgadm` Command” on page 231](#)
- InfiniBand devices – [Chapter 3, “Using InfiniBand Devices”](#)
- Accessing devices – [“Accessing Devices” on page 30](#)

Dynamic Reconfiguration and Hot-Plugging

Hot-plugging is an operation in which you add, remove, or replace system components while the system is running. *Dynamic reconfiguration* refers to the ability to adjust configuration of hot-plugged components. This term also refers to the general ability to move both hardware and software system resources around in the system or disable them in some way without physically removing them from the system.

In Oracle Solaris, you can add, remove, or replace devices while the system is still running provided that the system components support hot-plugging. Without that support, new devices are configured at boot time after the new components are installed on the system.

You can hot-plug bus types such as USB, Fibre Channel, SCSI, and so on. Additionally, you can hot-plug devices such as PCI and PCIe, USB, InfiniBand, and so on.

To perform hot-plugging and DR, you typically use the `cfgadm` command, which also guides you through the steps to complete these tasks. You can perform the following actions:

- Display system component status
- Test system components
- Change component configurations
- Display configuration help messages

Performing DR and hot-plugging require administrative privileges that are not generally granted to user accounts. Therefore, you must obtain the appropriate rights for these tasks. For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

You can use DR in conjunction with additional layered products from Oracle such as alternate pathing or failover software. These products work together to provide fault tolerance in the event of a device failure and thus ensure higher availability of the systems.

Without high availability software, you can replace a failed device only by manually stopping the appropriate applications, unmounting noncritical file systems, and then proceeding with the device replacement.

Note - Some systems have a mix of hot-pluggable slots and slots that are not hot-pluggable. Refer to your hardware documentation for information about hot-plugging devices on your specific system.

Attachment Points

Attachment points are locations on the system where DR can occur.

An attachment point consists of an occupant part and a receptacle.

- An *occupant* is a hardware component that can be configured into the system. An occupant's state can be either configured or unconfigured.
- A *receptacle* is the location that accepts the occupant. A receptacle's state can be either connected or disconnected. An empty state also exists but applies only to non-SCSI host bus adapters (HBAs).

The following table shows the combined states of occupants and receptacles on attachment points and the corresponding states of a device.

Occupant and Receptacle Combined States	Description of Device State
Unconfigured/Empty	Device is not physically connected (applies to non-SCSI HBAs only)

Occupant and Receptacle Combined States	Description of Device State
Unconfigured/Disconnected	Device is logically disconnected and unavailable, even though the device might be physically connected
Unconfigured/Connected	Device is logically connected but unavailable. Device is included in the <code>prtconf</code> command output
Configured/Connected	Device is connected and available

About Attachment Point Identification

Attachment points are represented by physical and logical attachment point IDs (Ap_Ids). The physical Ap_Id is the physical path name of the attachment point. The logical Ap_Id is a user-friendly alternative for the physical Ap_Id. For more information about Ap_Ids, refer to [cfgadm\(8\)](#) man page.

The logical Ap_Id for a device consists of the combination of the HBA Ap_Id and the device identifier, and follows the format *HBA-Ap_Id::device-identifier*. For example, the Ap_Id of a SCSI HBA is normally the controller number, such as `c0`. If the device identifier on the HBA is `dsk`, then that device's logical Ap_Id would be `c0::dsk`.

The device identifier is derived from the logical device name in the `/dev` directory. For example, a tape device with the logical device name `/dev/rmt/1` would have the device identifier `rmt/1`. Thus, the tape device's logical Ap_Id would be `c0::rmt/1`.

If an HBA Ap_Id has no controller number, an internally generated unique identifier is provided, such as `fas1:scsi`. If a device identifier cannot be derived from the logical name in the `/dev` directory, then an internally generated unique identifier is also provided. For example, for the `/dev/rmt/1` tape device, the logical name might be `st4` and the logical Ap_Id would be `c0::st4`.

For more information about SCSI Ap_Ids, refer to the [cfgadm_scsi\(8\)](#) man page.

Performing SCSI Hot-Plugging Operations

This section provides various procedures and examples for performing SCSI hot-plugging operations:

- “[Displaying Information About SCSI Devices](#)” on page 38
- “[Configuring or Unconfiguring a SCSI Controller](#)” on page 39
- “[Connecting or Disconnecting a SCSI Controller](#)” on page 39

- [“Configuring or Unconfiguring a SCSI Device” on page 40](#)
- [“How to Add a SCSI Device to a SCSI Bus” on page 41](#)
- [“How to Replace an Identical Device on a SCSI Controller” on page 42](#)
- [“How to Remove a SCSI Device” on page 44](#)
- [“Resolving a Failed SCSI Unconfigure Operation” on page 47](#)

Note - The SCSI framework generally supports hot-plugging of SCSI devices. However, always consult your hardware documentation to confirm whether hot-plugging is supported for your specific SCSI device.

Displaying Information About SCSI Devices

The best practice is to display information about the system devices before and after the actual hot-plugging action. You can first properly identify the bus or device to dynamically reconfigure, and then verify from the state of the bus or device that the reconfiguration completed successfully.

To display device information, use the `cfgadm -l[a]` command. You can choose to display only the attachment point information or include other information such as the controllers and attached devices.

Note - The command excludes any unsupported SCSI device from the information display.

The following examples show how to display SCSI device information.

- Show the state and condition of attachment points on the system:

```
# cfgadm -l
Ap_Id      Type      Receptacle  Occupant    Condition
c2         scsi-bus  connected   configured  unknown
c3         scsi-sas  connected   configured  unknown
```

- Show the state and condition of controllers and attached devices:

```
# cfgadm -al
Ap_Id      Type      Receptacle  Occupant    Condition
c2         scsi-bus  connected   configured  unknown
c2::dsk/c2t0d0  CD-ROM    connected   configured  unknown
c3         scsi-sas  connected   configured  unknown
c3::dsk/c3t0d0  disk      connected   configured  unknown
c3::dsk/c3t1d0  disk      connected   configured  unknown
c3::dsk/c3t2d0  disk      connected   configured  unknown
```

```
c3::dsk/c3t3d0      disk      connected  configured  unknown
```

Configuring or Unconfiguring a SCSI Controller

To configure or unconfigure a controller, use the following commands:

- To configure a controller: `cfgadm -c configure controller`
- To unconfigure a controller: `cfgadm -c unconfigure controller`

In both commands, *controller* refers to the controller number. For more information about the controller number, see [“About Attachment Point Identification” on page 37](#).

The following example unconfigures the SCSI controller c2.

```
# cfgadm -c unconfigure c2
```

The following example shows the state of the c2 controller after it has been unconfigured. The Occupant field in the output indicates the controller's new state.

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   unconfigured unknown    The controller is
unconfigured.
c2::dsk/c2t0d0 unavailable  connected   unconfigured unknown
c3             scsi-sas     connected   configured   unknown
c3::dsk/c3t0d0 disk        connected   configured   unknown
c3::dsk/c3t1d0 disk        connected   configured   unknown
c3::dsk/c3t2d0 disk        connected   configured   unknown
c3::dsk/c3t3d0 disk        connected   configured   unknown
```

Note - If an unconfigure operation fails, see [“Resolving a Failed SCSI Unconfigure Operation” on page 47](#).

Connecting or Disconnecting a SCSI Controller

To connect or disconnect a SCSI controller, use the following commands:

- To connect a controller: `cfgadm -c connect controller`
- To disconnect a controller: `cfgadm -c disconnect controller`

Disconnecting the controller suspends all I/O activity on the SCSI bus until you issue the `cfgadm -c connect` command.

The DR software initiated by the `disconnect` command performs some basic checking to prevent critical partitions from being disconnected. However, the software cannot detect all cases. If controllers on the system are for disks that contain critical components of the root file system, disconnecting these controllers would cause the system to hang and would require a system boot. Therefore, as a precaution, a confirmation prompt always appears after you issue the command to disconnect. The command is run only after you provide the confirmation.



Caution - Because of the risks in disconnect operations, always exercise caution to avoid causing the system to fall into an unknown state.

The following example disconnects the SCSI controller `c2` and also shows the confirmation prompt that follows the command.

```
# cfgadm -c disconnect c2
WARNING: Disconnecting critical partitions may cause system hang.
Continue (yes/no)?
```

The following example shows the state of the `c2` controller after it has been disconnected. The `Receptacle` field in the output indicates the controller's new state. Further, the devices that are attached to it are also disconnected.

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             unavailable   disconnected  configured  unknown    The controller is
disconnected.
c2::dsk/c2t0d0 unavailable   disconnected  configured  unknown    Attached device is
disconnected.
c3             scsi-sas     connected   configured  unknown
c3::dsk/c3t0d0 disk         connected   configured  unknown
c3::dsk/c3t1d0 disk         connected   configured  unknown
c3::dsk/c3t2d0 disk         connected   configured  unknown
c3::dsk/c3t3d0 disk         connected   configured  unknown
```

Configuring or Unconfiguring a SCSI Device

To configure or unconfigure a device, use the following commands:

- To configure a device: `cfgadm -c configure device`
- To unconfigure a device: `cfgadm -c unconfigure device`

In both commands, *device* refers to the device's logical `Ap_Id`. For more information, see [“About Attachment Point Identification” on page 37](#).

The following example configures the `c2t0d0` device. Based on the system's device configuration information, the device's logical `Ap_Id` is `c2::dsk/c2t0d0`.

```
# cfgadm -c configure c2::dsk/c2t0d0
```

The following example shows the state of the `c2t0d0` device after it has been configured. The `Occupant` field in the output indicates the device's new state.

```
# cfgadm -al
Ap_Id          Type      Receptacle  Occupant  Condition
c2             scsi-bus  connected   configured unknown
c2::dsk/c2t0d0 CD-ROM    connected   configured unknown    The device is configured.
c3            scsi-sas  connected   configured unknown
c3::dsk/c3t0d0 disk      connected   configured unknown
c3::dsk/c3t1d0 disk      connected   configured unknown
c3::dsk/c3t2d0 disk      connected   configured unknown
c3::dsk/c3t3d0 disk      connected   configured unknown
```

▼ SPARC: How to Add a SCSI Device to a SCSI Bus

Note - When you add devices, specify the `Ap_Id` of the SCSI HBA (controller) to which the device is attached, not the `Ap_Id` of the device itself.

1. **(Optional) Display the SCSI configuration to identify the bus to which to add the device.**

```
# cfgadm -al
```

2. **Add the device and switch it on.**

- a. **Add the device.**

```
# cfgadm -x insert_device controller
```

- b. **Type `y` at the prompt to proceed.**

I/O activity on the SCSI bus is suspended while the hot-plug operation is in progress.

- c. **Insert the device and switch its power on.**

3. **Verify that the device has been added.**

```
# cfgadm -al
```

Example 8 Adding a SCSI Device

In this example, a device is added to the controller c3.

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   configured  unknown
c2::dsk/c2t0d0 CD-ROM       connected   configured  unknown
c3             scsi-sas     connected   configured  unknown
c3::dsk/c3t0d0 disk         connected   configured  unknown
c3::dsk/c3t1d0 disk         connected   configured  unknown
c3::dsk/c3t2d0 disk         connected   configured  unknown

# cfgadm -x insert_device c3
Adding device to SCSI HBA: /devices/pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2
This operation will suspend activity on SCSI bus: c3
Continue (yes/no)? y
SCSI bus quiesced successfully.
It is now safe to proceed with hotplug operation.
```

After the device is added and power to the device is turned on, the operation continues and presents a confirmation prompt.

Enter y if operation is complete or n to abort (yes/no)? y

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   configured  unknown
c2::dsk/c2t0d0 CD-ROM       connected   configured  unknown
c3             scsi-sas     connected   configured  unknown
c3::dsk/c3t0d0 disk         connected   configured  unknown
c3::dsk/c3t1d0 disk         connected   configured  unknown
c3::dsk/c3t2d0 disk         connected   configured  unknown
c3::dsk/c3t3d0 disk         connected   configured  unknown    A disk is added to c3.
```

▼ SPARC: How to Replace an Identical Device on a SCSI Controller

Before You Begin Note the following conditions when replacing an identical device on a SCSI controller:

- If you are replacing a mirrored or unmirrored boot device that is part of a ZFS root pool, see [How to Perform System Archival and Recovery Procedures with Oracle Solaris 11 \(https://www.oracle.com/technical-resources/articles/it-infrastructure/admin-011-091-sol-dis-recovery.html\)](https://www.oracle.com/technical-resources/articles/it-infrastructure/admin-011-091-sol-dis-recovery.html).

- If the device is controlled by legacy volume management software, consult your volume management documentation for the specific steps to replace a device. If you have an active Oracle support plan, see the following references:

If you are using the Solaris Volume Manager, see "Solaris Volume Manager (SVM) How to Replace Internal System FC-AL Disks in 280R, V480, V490, V880, V890, and E3500 Servers (Doc ID 1010753.1) " at My Oracle Support.

1. (Optional) Display the SCSI configuration to identify the device to be replaced.

```
# cfgadm -al
```

2. Replace a device on the SCSI bus with another device of the same type.

a. Indicate the device to be replaced.

```
# cfgadm -x replace_device device-apid
```

b. Type *y* at the prompt to proceed.

I/O activity on the SCSI bus is suspended while the hot-plug operation is in progress.

c. Power off the device to be removed and remove it.

d. Add the replacement device and power it on.

The replacement device should be of the same type and at the same address (target and LUN) as the device to be removed.

e. At the prompt that appears, type *y* to confirm that the operation has been completed.

3. Verify that the device has been replaced.

```
# cfgadm -al
```

Example 9 Replacing Devices of the Same Type on a SCSI Bus

In this example, the disk `c3t3d0` is replaced by an identical device.

```
# cfgadm -al
c2          scsi-bus    connected  configured  unknown
c2::dsk/c2t0d0  CD-ROM    connected  configured  unknown
c3          scsi-sas    connected  configured  unknown
c3::dsk/c3t0d0  disk      connected  configured  unknown
c3::dsk/c3t1d0  disk      connected  configured  unknown
```

```
c3::disk/c3t2d0  disk          connected  configured  unknown
c3::disk/c3t3d0  disk          connected  configured  unknown
```

```
# cfgadm -x replace_device c3::disk/c3t3d0
Replacing SCSI device: /devices/pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@3,0
This operation will suspend activity on SCSI bus: c3
Continue (yes/no)? y
SCSI bus quiesced successfully.
It is now safe to proceed with hotplug operation.
```

Power to the device is turned off and the device is replaced. After the replacement device is installed and power is turned on, the operation continues with a prompt.

```
Enter y if operation is complete or n to abort (yes/no)? y
```

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   configured  unknown
c2::disk/c2t0d0 CD-ROM       connected   configured  unknown
c3             scsi-sas     connected   configured  unknown
c3::disk/c3t0d0 disk         connected   configured  unknown
c3::disk/c3t1d0 disk         connected   configured  unknown
c3::disk/c3t2d0 disk         connected   configured  unknown
c3::disk/c3t3d0 disk         connected   configured  unknown  The device is replaced.
```

▼ SPARC: How to Remove a SCSI Device

1. Identify the current SCSI configuration.

```
# cfgadm -al
```

2. Remove the SCSI device from the system.

a. Indicate the device to be removed.

```
# cfgadm -x remove_device device
```

b. Type **y** at the prompt to proceed.

I/O activity on the SCSI bus is suspended while the hot-plug operation is in progress.

c. Power off the device to be removed and remove it.

d. At the prompt that appears, type **y** to confirm that the operation has been completed.

Note - This step must be performed if you are removing a SCSI RAID device from a SCSI RAID array.

3. Verify that the device has been removed from the system.

```
# cfgadm -al
```

Example 10 Removing a SCSI Device

In this example, the disk `c3t3d0` is removed.

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   configured  unknown
c2::dsk/c2t0d0 CD-ROM       connected   configured  unknown
c3             scsi-sas     connected   configured  unknown
c3::dsk/c3t0d0 disk         connected   configured  unknown
c3::dsk/c3t1d0 disk         connected   configured  unknown
c3::dsk/c3t2d0 disk         connected   configured  unknown
c3::dsk/c3t3d0 disk         connected   configured  unknown

# cfgadm -x remove_device c3::dsk/c3t3d0
Removing SCSI device: /devices/pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@3,0
This operation will suspend activity on SCSI bus: c3
Continue (yes/no)? y
SCSI bus quiesced successfully.
It is now safe to proceed with hotplug operation.
```

After power to the device has been turned off and the device is removed, the operation continues with a prompt.

```
Enter y if operation is complete or n to abort (yes/no)? y
```

```
# cfgadm -al
Ap_Id          Type          Receptacle  Occupant    Condition
c2             scsi-bus     connected   configured  unknown
c2::dsk/c2t0d0 CD-ROM       connected   configured  unknown
c3             scsi-sas     connected   configured  unknown
c3::dsk/c3t0d0 disk         connected   configured  unknown
c3::dsk/c3t1d0 disk         connected   configured  unknown
c3::dsk/c3t2d0 disk         connected   configured  unknown
```

Troubleshooting SCSI Configuration Problems

This section explains error messages and provides possible solutions to SCSI configuration problems. For more information about troubleshooting SCSI configuration problems, see the [cfgadm\(8\)](#) man page.

Busy Component System Errors

To troubleshoot the error `cfgadm: Component system is busy, try again: failed to offline: device-path`, note the resource information provided with the message.

```
cfgadm: Component system is busy, try again: failed to offline:
device-path
Resource          Information
-----
/dev/dsk/c1t0d0s0  mounted filesystem "/file-system"
```

Cause: You attempted to remove or replace a device with a mounted file system.

Solution: Unmount the indicated file system and retry the `cfgadm` operation.

```
cfgadm: Component system is busy, try again: failed to offline:
device-path
Resource          Information
-----
/dev/dsk/device-name  swap area
```

Cause: You attempted to use the `cfgadm` command to remove a system resource, such as a swap device or a dedicated dump device, but the system resource was still active.

Solution: Unconfigure the swap area on the specified device and retry the `cfgadm` operation.

```
cfgadm: Component system is busy, try again: failed to offline:
device-path
Resource          Information
-----
/dev/dsk/device-name  dump device (swap)
```

Cause: You attempted to remove or replace a dump device that is configured on a swap area.

Solution: Unmount the file system that is configured on the swap area and retry the `cfgadm` operation.

```
cfgadm: Component system is busy, try again: failed to offline:
device-path
Resource          Information
```

```
-----  
/dev/dsk/device-name dump device (dedicated)
```

Cause: You attempted to remove or replace a dedicated dump device.

Solution: Unconfigure the dedicated dump device and retry the `cfgadm` operation.

Resolving a Failed SCSI Unconfigure Operation

If you perform a SCSI unconfigure operation and one or more targeted devices are busy, the operation fails. Subsequent DR operations on this controller and target devices will also fail. The following message is displayed:

```
dr in progress
```

To resolve the failed operation, reconfigure the controller.

```
# cfgadm -c configure device-apid
```

After verifying that the device has been configured, you can proceed with unconfiguring the device again.

PCI or PCIe Hot-Plugging With the `cfgadm` Command

You can hot-plug PCI adapter cards only if their corresponding device drivers support hot-plugging.

The LED indicators on the system often indicate the status of the slot's hot-plug operation. In the case of PCI Express devices, the LED behavior matches the behavior defined in the PCI Express specification. For other types of devices, the behavior might be platform dependent. Refer to your platform guide for specific details.

For PCI Express devices, when the Attention button is pressed, the power indicator blinks to indicate the beginning of a state transition. The blinking ends when the state transition has ended.

Displaying PCI Slot Configuration Information

The `cfgadm` command displays only hot-pluggable PCI devices and slots. It does not provide information about PCI devices that are not hot-pluggable.

Note - The logical `Ap_Id` in most cases should match the slot label that is silk-screened on the system chassis. Refer to your platform guide for the `cfgadm` output of the hot-pluggable slots. The `Busy` field can be displayed to ensure that the `Ap_Id` is not transitioning to another state before a hot-plug operation is attempted.

You can also use the `prtconf` command to display additional configuration information that pertains to the hardware, such as verifying that added hardware is correctly configured. For example, after a configure operation, use the `prtconf -D` command to verify that the driver is attached to the newly installed hardware device. If the device driver has not been added to the system prior to hardware configuration, you can manually add it by using the `add_drv` command.

For more information, see [prtconf\(8\)](#) and [add_drv\(8\)](#).

The following examples show how to display the status of PCI hot-pluggable devices and slots on the system. You must have the appropriate administrator rights to run these commands.

Note - For brevity, the examples on this section list only PCI attachment points. The attachment points that are displayed on your system depend on your system configuration.

EXAMPLE 11 Displaying PCI Slot Configuration Information

```
# cfgadm
Ap_Id          Type          Receptacle  Occupant    Condition
pci1:hpc0_slot0  unknown      empty       unconfigured unknown
pci1:hpc0_slot1  unknown      empty       unconfigured unknown
pci1:hpc0_slot2  unknown      empty       unconfigured unknown
pci1:hpc0_slot3  ethernet/hp  connected   configured  ok
pci1:hpc0_slot4  unknown      empty       unconfigured unknown
```

EXAMPLE 12 Displaying Specific PCI Device Information

```
# cfgadm -s "cols=ap_id:type:info" pci
Ap_Id          Type          Information
pci1:hpc0_slot0  unknown      Slot 7
pci1:hpc0_slot1  unknown      Slot 8
pci1:hpc0_slot2  unknown      Slot 9
pci1:hpc0_slot3  ethernet/hp  Slot 10
pci1:hpc0_slot4  unknown      Slot 11
```

In the output, `pci1:hpc0_slot0` is the logical `Ap_Id` for the hot-pluggable slot, Slot 7. The component `hpc0` indicates the hot-pluggable adapter card for this slot, and `pci1` indicates the

PCI bus instance. The Type field indicates the type of PCI adapter card that is present in the slot.

EXAMPLE 13 Displaying PCIe Slot Configuration Information

```
# cfgadm pci
Ap_Id          Type          Receptacle  Occupant    Condition
pcie1          unknown      empty       unconfigured unknown
pcie2          unknown      empty       unconfigured unknown
pcie3          unknown      empty       unconfigured unknown
pcie4          etherne/hp   connected   configured  ok
pcie5          pci-pci/hp   connected   configured  ok
pcie6          unknown      disconnected unconfigured unknown
```

EXAMPLE 14 Displaying Specific PCIe Device Information

```
# cfgadm -s "cols=ap_id:busy:o_state" pci
Ap_Id          Busy      Occupant
pcie1          n         unconfigured
pcie2          n         unconfigured
pcie3          n         unconfigured
pcie4          n         configured
pcie5          n         configured
pcie6          n         configured
```

- Displaying PCI slot configuration information.
- Displaying specific PCI device information.
- Displaying PCIe slot configuration information.
- Displaying specific PCIe device information.

Adding and Removing PCI Adapter Cards

- If you are adding adapter cards, make sure that slots are available.
- If you are removing adapter cards, ensure the following:
 - The adapter card is hosting only nonvital system resources.
 - Critical resources are accessible through an alternate pathway.

For example, if a system has only one Ethernet card installed on it, you cannot remove the Ethernet card or the network connection will be lost. You would need additional layered software support to keep the network connection active.

▼ How to Add a PCI or PCIe Adapter Card

1. List the hot-pluggable slot and open latches.

```
# cfgadm pci
```

2. Insert the adapter card into the slot.

Follow the appropriate instructions in your platform guide.

3. Determine the slot that the inserted adapter card occupies.

- For PCI adapter cards:

```
# cfgadm
```

- For PCIe adapter cards:

```
# cfgadm pci
```

4. Connect the power to the slot.

- For either PCI or PCIe adapter cards: Issue the `cfgadm` command.

```
# cfgadm -c connect PCI-device
```

- For a PCIe adapter card: Use the autoconfiguration method defined by your platform guide. For many PCIe devices, this process involves pressing the slot's Attention button.

5. Confirm that the attachment point is connected.

- For PCI adapter cards:

```
# cfgadm
```

- For PCIe adapter cards:

```
# cfgadm pci
```

6. For PCI adapter cards, use the `cfgadm` command to configure the card.

For PCIe adapter cards, if you are using the autoconfiguration method, this step might not be necessary. Refer to your platform guide for more information.

```
# cfgadm -c configure pci-device
```

7. Verify the configuration of the adapter card in the slot.

- For PCI adapter cards:

```
# cfgadm
```

- For PCIe adapter cards:

```
# cfgadm pci
```

8. Configure any supporting software if this device is a new device.

For example, if this device is an Ethernet card, use the `ipadm` command to set up the interface.

```
# ipadm create-addr IP-interface
```

Note - On some platforms, the autoconfiguration method for installing software can be enabled or disabled at boot. Set the autoconfiguration method as appropriate for your environment.

Example 15 Adding a PCIe Adapter Card

In this example, the `pcie3` card is added to the system.

```
# cfgadm pci
Ap_Id  Type      Receptacle  Occupant  Condition
pcie1  unknown   empty       unconfigured  unknown
pcie2  unknown   empty       unconfigured  unknown
pcie3  unknown   disconnected unconfigured  unknown
pcie4  unknown   empty       unconfigured  unknown
pcie5  pci-pci/hp  connected  configured    ok
pcie6  unknown   disconnected unconfigured  unknown

# cfgadm -c connect pcie3

# cfgadm pci
Ap_Id  Type      Receptacle  Occupant  Condition
pcie1  unknown   empty       unconfigured  unknown
pcie2  unknown   empty       unconfigured  unknown
pcie3  unknown   connected   unconfigured  unknown    Device is added.
pcie4  unknown   empty       unconfigured  unknown
pcie5  pci-pci/hp  connected  configured    ok
pcie6  unknown   disconnected unconfigured  unknown

# cfgadm -c configure pcie3

# cfgadm pci
Ap_Id  Type      Receptacle  Occupant  Condition
```

```
pcie1  unknown    empty    unconfigured  unknown
pcie2  unknown    empty    unconfigured  unknown
pcie3  ethernet/hp  connected  configured    unknown    Device is configured.
pcie5  pci-pci/hp   connected  configured    ok
pcie6  unknown    disconnected unconfigured  unknown

# ipadm create-addr -a 192.168.1.10 net1
```

▼ How to Remove a PCI Adapter Card

1. Determine the slot that the adapter card is in.

- For PCI adapter cards:

```
# cfgadm
```

- For PCIe adapter cards:

```
# cfgadm pci
```

2. Stop any application that has the device open.

For example, if the device is an Ethernet card with a configured IP interface, remove the IP interface.

```
# ipadm delete-ip IP-interface
```

3. Unconfigure the device manually.

- For either PCI or PCIe adapter cards: Issue the following command:

```
# cfgadm -c unconfigure PCI-device
```

- For a PCIe adapter card, use the autoconfiguration method for your platform.

For example, for many platforms, you would press the slot's Attention button.

4. Confirm that the device has been unconfigured.

- For PCI adapter cards:

```
# cfgadm
```

- For PCIe adapter cards:

```
# cfgadm pci
```

5. Disconnect the power to the slot manually.

For PCIe adapter cards, if you are using the autoconfiguration method, this step might not be necessary. Refer to your platform guide for more information.

```
# cfgadm -c disconnect PCI-device
```

6. Confirm that the device has been disconnected.

■ **For PCI adapter cards:**

```
# cfgadm
```

■ **For PCIe adapter cards:**

```
# cfgadm pci
```

7. Remove the PCI adapter card by following the instructions in your platform guide.

8. Verify that the Receptacle state is empty.

■ **For PCI adapter cards:**

```
# cfgadm
```

■ **For PCIe adapter cards:**

```
# cfgadm pci
```

Note - On some platforms, the autoconfiguration method can be enabled or disabled at boot. Set the autoconfiguration method as appropriate for your environment.

Example 16 Removing a PCIe Adapter Card

In this example, the pcie4 card is removed.

```
# cfgadm pci
Ap_Id      Type      Receptacle  Occupant    Condition
pcie1      unknown  empty       unconfigured unknown
pcie2      unknown  empty       unconfigured unknown
pcie3      unknown  empty       unconfigured unknown
```

```
pcie4      etherne/hp  connected  configured  ok
pcie5      pci-pci/hp  connected  configured  ok
pcie6      unknown     disconnected unconfigured unknown
```

```
# ipadm delete-ip net1
```

```
# cfgadm -c unconfigure pcie4
```

```
# cfgadm pci
```

Ap_Id	Type	Receptacle	Occupant	Condition
pcie1	unknown	empty	unconfigured	unknown
pcie2	unknown	empty	unconfigured	unknown
pcie3	unknown	empty	unconfigured	unknown
pcie4	unknown	connected	unconfigured	unknown
pcie5	pci-pci/hp	connected	configured	ok
pcie6	unknown	disconnected	unconfigured	unknown

The device is unconfigured.

```
# cfgadm -c disconnect pcie4
```

```
# cfgadm pci
```

Ap_Id	Type	Receptacle	Occupant	Condition
pcie1	unknown	empty	unconfigured	unknown
pcie2	unknown	empty	unconfigured	unknown
pcie3	unknown	empty	unconfigured	unknown
pcie4	unknown	disconnected	unconfigured	unknown
pcie5	pci-pci/hp	connected	configured	ok
pcie6	unknown	disconnected	unconfigured	unknown

Power is disconnected.

After the device is removed, verify that the receptacle is empty.

```
# cfgadm pci
```

Ap_Id	Type	Receptacle	Occupant	Condition
pcie1	unknown	empty	unconfigured	unknown
pcie2	unknown	empty	unconfigured	unknown
pcie3	unknown	empty	unconfigured	unknown
pcie4	unknown	empty	unconfigured	unknown
pcie5	pci-pci/hp	connected	configured	ok
pcie6	unknown	disconnected	unconfigured	unknown

The receptacle is empty.

Troubleshooting PCI Configuration Problems

This section describes error messages that indicate problems with PCI configuration and possible solutions.

```
cfgadm: Configuration operation invalid: invalid transition
```

Cause: An invalid transition was attempted.

Solution: Check whether the `cfgadm -c` command was issued appropriately. Use the `cfgadm` command to check the current receptacle and occupant state and to make sure that the `Ap_Id` is correct.

```
cfgadm: Attachment point not found
```

Cause: The specified attachment point was not found.

Solution: Check whether the attachment point is correct. Use the `cfgadm` command to display a list of available attachment points. Also, check the physical path to see whether the attachment point is still there.

PCIe Hot-Plugging With the hotplug Command

You can use the `hotplug` command with PCI Express (PCIe) and PCI SHPC devices to manage hot-pluggable connections, which can be a connector or a port. A *hotplug connector* is a physical representation in the system where a component is inserted or removed. A *hotplug port* is a logical representation in the system device tree where the connection of a device to the system is managed.

You can use the `hotplug` features to take a device, including an on-board device, online or offline without physically adding or removing the device from the system.

In order to manage devices with the `hotplug` command, you must enable the `hotplug` service. Except on sun4v platforms, the service is disabled by default on most platforms. To enable the `hotplug` service, type the following command:

```
# svcadm enable svc:/system/hotplug:default
```

Hot Plug Command Uses

The following examples show different uses of the `hotplug` command:

- Displaying all the system's PCI/PCIe hot-pluggable connectors or ports. These ports can be virtual or physical.

```
# hotplug list -lv
```

- Configuring or unconfiguring PCI/PCIe devices.
 - To configure a device: `hotplug enable path connector`
 - To unconfigure a device: `hotplug disable path connector`

The following example configures an Ethernet card in a PCIe slot.

```
# hotplug enable /pci0,0 pci0
```

- Attaching or detaching the device driver for a PCI device node.
 - To attach a device driver: `hotplug online path port`
 - To detach a device driver: `hotplug offline path port`

The following example detaches the device driver for a PCI device node to take it offline.

```
# hotplug offline /pci0,0/pci1 pci.0,2
```

- Installing or uninstalling services that can be supported by the drivers of the device on a specific port.
 - To install a service: `hotplug install path port`
 - To uninstall a service: `hotplug uninstall path port`

The following example installs dependent ports of an IOV physical function.

```
# hotplug install /pci@400/pci@1/pci@0/pci@4 pci.0,1
```

- Listing information about all connectors, ports, and their associated devices in verbose mode.

```
# hotplug list -v path connection
```

The following example displays IOV virtual functions that were probed after the installation operation in the example for the `install` command.

```
# hotplug list -v /pci@400/pci@1/pci@0/pci@4 pci.0,1
<pci.0,1> (ONLINE)
{ IOV physical function }
{ IOV virtual function 'pci.0,81' }
{ IOV virtual function 'pci.0,83' }
{ IOV virtual function 'pci.0,85' }
{ IOV virtual function 'pci.0,87' }
<pci.0,81> (OFFLINE)
ethernet@0,81
<pci.0,83> (OFFLINE)
ethernet@0,83
<pci.0,85> (OFFLINE)
ethernet@0,85
<pci.0,87> (OFFLINE)
```

```
ethernet@0,87
```

Troubleshooting PCI Hot-Plug Operations

This section describes error messages that indicate problems while you are performing PCI hot-plug operations, and possible solutions.

```
/pci@0,0/pci10de,5d@e <pci.a,1> (MAINTENANCE)
.
.
./pci@0,0/pci108e,534a@d <pci.0,0> (MAINTENANCE-SUSPENDED)
```

Cause: These messages indicate that a fault event or a maintenance operation occurred. The MAINTENANCE states mean that a device in use is not fully operational. The MAINTENANCE-SUSPENDED state means that the device is *live suspended* due to a maintenance operation such as the reconfiguration of a device hardware.

```
ERROR: hotplug service is not available.
```

Cause: The hotplug service is disabled.

Solution: Enable the hotplug service.

```
# svcadm enable svc:/system/hotplug:default
```

```
ERROR: there are no connections to display.
(See hotplug(8) for more information.)
```

Cause: Either the system does not have any supported I/O buses or the system might have other hot-pluggable I/O devices but you need to use the `cfgadm` command rather than the `hotplug` command to manage them.

```
# hotplug poweroff /pci@13c/pci@1/SYS/RCSA/PCIE11
```

```
ERROR: devices or resources are busy.
```

Cause: You are attempting to offline a port with dependent devices that are currently in use by the system might fail.

Solution: Retry to offline the port using the `hotplug poweroff` command after two minutes until the active holds are released.

```
# hotplug uninstall /pci@400/pci@1/pci@0/pci@4 pci.0,0
```

```
ERROR: devices or resources are busy.
```

```
ethernet@0,81:
```

```
...
```

Cause: You are attempting to uninstall dependent ports of an IOV physical function while a dependent IOV virtual function is busy.

```
# hotplug disable Slot0
ERROR: devices or resources are busy.
/pci@0,0/pci8086,3a40@1c/pci108e,0@0:
{ Hold: module specfs (modid=3): Device opened. }
{ Hold: module genunix (modid=1): Network datalink. }
{ Open: module udp6 (modid=81). }
{ Open: module udp (modid=80). }
{ Network interface net0 }
{ net0: hosts IP addresses: 192.0.2.0 }
{ Plumbed IP Address }
```

Cause: You are attempting to disable a PCIe slot which contains busy devices. In this example, a network adapter card with one network interface is inserted in the slot. The interface has a plumbed IP address. Extra information is displayed about related opens and holds on this device:

- Hold from `specfs` is related to opening the device.
- Hold from `genunix` is related to a configured network datalink.
- Opens from `udp` and `udp6` are related to IP address plumbing.

Solution: The solution depends on why the device is busy. In this example, you must unplumb the IP address by using the `ipadm` command before trying again. For more information, see the [ipadm\(8\)](#).

```
# hotplug offline pci@0,0 pci.1,0
ERROR: devices or resources are busy.
/pci@0,0/pci8086,3408@1/pci1000,1000@0/sd@0,0:
{ Hold: module devfs (modid=6): Device lookup. }
{ Hold: module specfs (modid=3): Device opened. }
{ Open: process format[123501]. }
{ Open: module zfs (modid=49). }
```

Cause: You are attempting to offline a busy device. In the example, it is a disk device which is used by the ZFS file system and is also opened by using the `format` command.

Extra information is displayed about related holds on the device:

- Hold from `specfs` is related to opening the device.
- Hold from `devfs` is related to using a special device file in the `/devices` filesystem when opening the device.

Solution: The solution depends on why the device is busy. In this example, you must reconfigure ZFS to stop using the disk and stop the `format` command before trying again. For more information, see the [format\(8\)](#) man page.

Performing SATA Hot-Plugging Operations

SATA controller and port multiplier device ports are represented by attachment points in the device tree. SATA devices that are connected and configured on the system are shown as attachment point name extensions. The terms "attachment point" and "SATA port" can be used interchangeably.

The `cfgadm` syntax to display device information is the same as for SCSI devices, `cfgadm -aL`. However, for brevity, the examples in this section use the `grep` utility to directly display a specific device's information.

The following example shows how SATA information is displayed by the `cfgadm` command.

```
% cfgadm -aL
Ap_Id          Type  Receptacle  Occupant  Condition
sata0/0::dsk/c7t0d0  disk  connected   configured ok
sata0/1::dsk/c7t1d0  disk  connected   configured ok
sata0/2::dsk/c7t2d0  disk  connected   configured ok
sata0/3::dsk/c7t3d0  disk  connected   configured ok
.
.
.
```

Configuring Or Unconfiguring a SATA Device

Use the following commands to configure or unconfigure a SATA device:

- To configure a SATA controller: `cfgadm -c configure controller`
- To unconfigure a SATA controller: `cfgadm -c unconfigure controller` – unconfigures a SATA controller.

In both commands, *controller* refers to the SATA HBA Ap_Id, such as `sata0/0`. For more information about the Ap_Id, see [“About Attachment Point Identification” on page 37](#).

The following example configures the `c7t0d0` device.

```
# cfgadm -c configure c7t0d0
```

The following example shows the state of the `c7t0d0` device after it has been configured.

```
# cfgadm | grep sata0/0
sata0/0  disk          connected   unconfigured ok
```

▼ How to Replace a SATA Device

You must unconfigure a SATA device first before replacing it. You configure the device after replacing it.

1. **Become an administrator.**
2. **Identify the device to be replaced.**

```
# cfgadm -al
```

3. **Unconfigure the device.**

```
# cfgadm -c unconfigure controller
```

4. **Confirm that the device is unconfigured.**

```
# cfgadm | grep controller
```

5. **Remove the device and replace it with a device of a similar type.**

6. **Configure the replaced device.**

```
# cfgadm -c configure controller
```

7. **Confirm that the device is configured.**

```
# cfgadm | grep controller
```

Example 17 Replacing a SATA Device

In this example, the `c7t3d0` device is replaced with a device of a similar type.

```
# cfgadm -al
Ap_Id          Type      Receptacle  Occupant  Condition
sata0/0::dsk/c7t0d0  disk     connected   configured ok
sata0/1::dsk/c7t1d0  disk     connected   configured ok
sata0/2::dsk/c7t2d0  disk     connected   configured ok
sata0/3::dsk/c7t3d0  disk     connected   configured ok
.
.
.
# cfgadm -c unconfigure sata0/3

# cfgadm | grep sata0/3
sata0/3          disk     connected   unconfigured ok
```

After the c7t3d0 device is replaced, configure the replacement device.

```
# cfgadm -c configure sata0/3

# cfgadm | grep sata0/3
sata0/3::disk/c7t3d0      disk          connected  configured  ok
```

Troubleshooting SATA Configuration Problems

This section describes error messages that indicate problems while performing hot-plugging operations with SATA devices and possible solutions.

```
do_control_ioctl: open failed: errno:2
cfgadm: Library error: Cannot open ap_id: /devices/pci@0,0/pci10...
No such file or directory
```

Cause: Might indicate that you are configuring or unconfiguring the device by specifying the device's logical Ap_Id with the `cfgadm` command, such as `sata0/0::disk/c7t0d0`. Use the HBA Ap_Id or controller number instead.

```
Unconfigure the device at: /devices/pci@2,0/pci1022...
This operation will suspend activity on the SATA device
Continue (yes/no)? y
cfgadm: Hardware specific failure: Failed to unconfig device \
          at ap_id: /devices/pci@2,0/pci10...
```

Cause: Indicates that you are unconfiguring a device that is part of an active ZFS storage pool. Remove that device from the pool first.

Reconfiguration Coordination Manager (RCM) Script Overview

The Reconfiguration Coordination Manager (RCM) is the framework that manages the dynamic removal of system components. By using RCM, you can register and release system resources in an orderly manner.

The RCM script feature simplifies and better controls the DR process. By creating an RCM script, you can do the following:

- Automatically release a device when you dynamically remove a device. This process also closes the device if the device is opened by an application.
- Run site-specific tasks when you dynamically remove a device from the system.

- Write customized scripts to perform other shutdown operations when a reconfiguration request is received that affects the resources that are registered in the script.

Note - The `cfgadm -f` command can force a reconfiguration operation. However, this command might leave applications in an unknown state. Manually releasing resources from applications commonly causes errors so avoid using this syntax to perform reconfigurations.

About RCM Scripts

An RCM script can be any of the following script types:

- An executable shell script (Perl, sh, csh, or ksh) or binary program that the RCM daemon runs. Perl is the recommended language.
- A script that runs in its own address space by using the user ID of the script file owner.
- A script that is run by the RCM daemon when you use the `cfgadm` command to dynamically reconfigure a system resource.

You can use an RCM script to release a device from an application when you dynamically remove a device. If the device is currently open, the RCM script also closes the device. For example, an RCM script for a tape backup application can inform the tape backup application to close the tape drive or shut down the tape backup application.

You run an RCM script using the following syntax:

```
$ script-name command [args ...]
```

An RCM script performs the following basic steps:

1. Gets the RCM command from command-line arguments.
2. Runs the command.
3. Writes the results to `stdout` as name-value pairs.
4. Exits with the appropriate exit status.

The RCM daemon runs one instance of a script at a time. If a script is running, the RCM daemon does not run the script until the first script exits.

RCM Script Commands

You must include the following RCM commands in an RCM script:

- `scriptinfo` – Gathers script information

- `register` – Registers interest in resources
- `resourceinfo` – Gathers resource information

The following RCM commands are optional:

- `queryremove` – Queries whether the resource can be released
- `preremove` – Releases the resource
- `postremove` – Provides post-resource removal notification
- `undoremove` – Reverses the actions done in the `preremove` operation

For a complete description of these RCM commands, see the [rcmscript\(5\)](#) man page.

When you dynamically remove a device, the RCM daemon runs the following commands:

- The script's `register` command, which gathers the list of resources (device names) that are identified in the script.
- The script's `queryremove` and `preremove` commands prior to removing the resource if the script's registered resources are affected by the dynamic remove operation.
- The script's `postremove` command if the remove operation succeeds. However, if the remove operation fails, the RCM daemon runs the script's `undoremove` command.

RCM Script Directories

You store RCM scripts in locations by their use:

- Scripts for specific systems – `/etc/rcm/scripts`
- Scripts for a specific hardware implementation – `/usr/platform/`uname -i`/lib/rcm/scripts`
- Scripts for a specific hardware class – `/usr/platform/`uname -m`/lib/rcm/scripts`
- Scripts for any hardware – `/usr/lib/rcm/scripts`

Using RCM Scripts

This section describes some preliminary steps before writing an RCM script for applications or site customization, and provides procedures for installing and testing RCM scripts. It also includes an extended example of a tape backup RCM script.

Preparations for Writing an RCM Script for an Application

You need to gather some information before writing an RCM script for applications.

1. Identify the resources the application uses that would affect the application, which you can potentially remove.

These are resources that you can potentially remove which would affect the application.

```
# cfgadm -aL
```

2. Identify the application commands for releasing the resource in an orderly fashion.

Consult your application's documentation for these commands.

3. Identify the script commands that remove the resource, including those notifying the application that the resource has been removed.

Refer to the [rcmscript\(5\)](#) man page.

4. Identify the script commands that would notify the application about the availability of the resource if the resource is replaced, including those that automatically run if the resource removal fails.

5. Write the RCM script and assign it a name that uses the following format:

vendor,service

- *vendor* – The stock symbol of the vendor that provides the script or any distinct name that identifies the vendor.
- *service* – The service that the script represents

Preparations for Writing an RCM Script for Specific Site Use

You need to gather some information before writing an RCM script for site customization.

1. Identify the resources to be dynamically removed.

Make sure to list the devices' logical Ap_Id.

```
# cfgadm -aL
```

2. Identify the applications and the commands to stop them before resources can be removed.

Consult the application documentation for these commands.

3. Identify the script commands to run before the resources are removed.

Refer to the [rcmscript\(5\)](#) man page.

4. Identify the script commands to run after the resources are removed.
Refer to the [rcmscript\(5\)](#) man page.

▼ How to Install an RCM Script

1. **Write the RCM script and assign it a name that uses the following format:**

vendor,service

vendor The stock symbol of the vendor that provides the script or any distinct name that identifies the vendor.

service The service that the script represents

2. **Become an administrator.**
3. **Copy the script to the appropriate directory.**

See “[RCM Script Directories](#)” on page 63.

For example:

```
# cp ABC,sample.pl /usr/lib/rcm/scripts
```

4. **Change the user ID and the group ID of the script.**

```
# chown user:group /usr/lib/rcm/scripts/ABC,sample.pl
```

5. **Send `SIGHUP` to the RCM daemon.**

```
# pkill -HUP -x -u root rcm_daemon
```

▼ How to Test an RCM Script

1. **Set environment variables, such as `RCM_ENV_FORCE`, in the command-line shell before running your script.**

For example, in the Korn shell, you set environment variables as follows:

```
$ export RCM_ENV_FORCE=TRUE
```

2. **Test the script by running the script commands manually from the command line.**

For example:

```
$ script-name scriptinfo
$ script-name register
$ script-name preremove resource-name
$ script-name postremove resource-name
```

3. **Make sure that each RCM script command in your script prints appropriate output to `stdout`.**
4. **Install the script in the appropriate script directory.**
For more information, see [“How to Install an RCM Script” on page 65](#).
5. **Test the script by initiating a dynamic remove operation.**



Caution - Make sure that you are familiar with these commands because they can alter the state of the system and cause system failures.

For example, if your script registers the device `/dev/dsk/c1t0d0s0`, you might try the following commands:

```
$ cfgadm -c unconfigure c1::dsk/c1t0d0
$ cfgadm -f -c unconfigure c1::dsk/c1t0d0
$ cfgadm -c configure c1::dsk/c1t0d0
```

▼ How to Remove an RCM Script

1. **Become an administrator.**
2. **Remove the script from the RCM script directory.**

For example:

```
# rm /usr/lib/rcm/scripts/ABC,sample.pl
```

3. **Send `SIGHUP` to the RCM daemon.**

```
# pkill -HUP -x -u root rcm_daemon
```

Tape Backup RCM Script Example

The example in this section illustrates how to use an RCM script for tape backups.

Tape Backup RCM Script Actions

The tape backup RCM script performs the following steps:

1. Sets up a dispatch table of RCM commands.
2. Calls the dispatch routine that corresponds to the specified RCM command and exits with status 2 for unimplemented RCM commands.
3. Sets up the `scriptinfo` section.

```
rcm_script_func_info=Tape backup appl script for DR
```

4. Registers all tape drives in the system by printing all tape drive device names to `stdout`.

```
rcm_resource_name=/dev/rmt/$f
```

If an error occurs, the script prints the error information to `stdout`.

```
rcm_failure_reason=$errmsg
```

5. Sets up the resource information for the tape device.

```
rcm_resource_usage_info=Backup Tape Unit Number $unit
```

6. Sets up the `preremove` information by checking whether the backup application is using the device. If the backup application is not using the device, the dynamic reconfiguration operation continues. If the backup application is using the device, the script checks `RCM_ENV_FORCE`. If `RCM_ENV_FORCE` is set to `FALSE`, the script denies the dynamic reconfiguration operation and prints the following message:

```
rcm_failure_reason=tape backup in progress pid=...
```

If `RCM_ENV_FORCE` is set to `TRUE`, the backup application is stopped and the reconfiguration operation proceeds.

Tape Backup Reconfiguration Scenarios

If you use the `cfgadm` command to remove a tape device without the RCM script and the backup application is using the tape device, the operation fails.

If you use the `cfgadm` command to remove a tape device with the RCM script, various outcomes might occur.

- If the backup application is not using the tape device, the operation succeeds.
- If you use the `cfgadm` command without the `-f` option and the backup application is using the tape device, the operation fails with an error message similar to the following example:

```
tape backup in progress pid=...
```

- If you use the `cfgadm -f` command and the backup application is using the tape device, the script stops the backup application and the `cfgadm` operation succeeds.

Example – Tape Backup RCM Script

```
#!/usr/bin/perl -w
#
# A sample site customization RCM script.
#
# When RCM_ENV_FORCE is FALSE this script indicates to RCM that it cannot
# release the tape drive when the tape drive is being used for backup.
#
# When RCM_ENV_FORCE is TRUE this script allows DR removing a tape drive
# when the tape drive is being used for backup by killing the tape
# backup application.
#

use strict;

my ($cmd, %dispatch);
$cmd = shift(@ARGV);
# dispatch table for RCM commands
%dispatch = (
    "scriptinfo" => \&do_scriptinfo,
    "register" => \&do_register,
    "resourceinfo" => \&do_resourceinfo,
    "queryremove" => \&do_preremove,
    "preremove" => \&do_preremove
);

if (defined($dispatch{$cmd})) {
    &{$dispatch{$cmd}};
} else {
    exit (2);
}

sub do_scriptinfo
{
    print "rcm_script_version=1\n";
    print "rcm_script_func_info=Tape backup appl script for DR\n";
    exit (0);
}
```

```
sub do_register
{
my ($dir, $f, $errmsg);

$dir = opendir(RMT, "/dev/rmt");
if (!$dir) {
$errmsg = "Unable to open /dev/rmt directory: $!";
print "rcm_failure_reason=$errmsg\n";
exit (1);
}

while ($f = readdir(RMT)) {
# ignore hidden files and multiple names for the same device
if (($f !~ /\^\.\/) && ($f =~ /^[0-9]+$/)) {
print "rcm_resource_name=/dev/rmt/$f\n";
}
}

closedir(RMT);
exit (0);
}
sub do_resourceinfo
{
my ($rsrc, $unit);

$rsrc = shift(@ARGV);
if ($rsrc =~ /\^\/dev\/rmt\/([0-9]+)$/) {
$unit = $1;
print "rcm_resource_usage_info=Backup Tape Unit Number $unit\n";
exit (0);
} else {
print "rcm_failure_reason=Unknown tape device!\n";
exit (1);
}
}

sub do_preremove
{
my ($rsrc);

$rsrc = shift(@ARGV);

# check if backup application is using this resource
#if (the backup application is not running on $rsrc) {
# allow the DR to continue
#     exit (0);
#}
}
```

```
#
# If RCM_ENV_FORCE is FALSE deny the operation.
# If RCM_ENV_FORCE is TRUE kill the backup application in order
# to allow the DR operation to proceed
#
if ($ENV{RCM_ENV_FORCE} eq 'TRUE') {
if ($cmd eq 'preremove') {
# kill the tape backup application
}
exit (0);
} else {
#
# indicate that the tape drive can not be released
# since the device is being used for backup by the
# tape backup application
#
print "rcm_failure_reason=tape backup in progress pid=...\n"
;
exit (3);
}
}
```

Using InfiniBand Devices

This chapter provides general overview and step-by-step instructions for using InfiniBand (IB) devices in your network. It covers the following topics:

- “About InfiniBand Devices” on page 71
- “Dynamically Reconfiguring IB Devices” on page 74
- “Administering IPoIB Devices” on page 81
- “Administering EoIB Datalinks” on page 86
- “Monitoring and Troubleshooting IB Devices” on page 92

For more information about dynamic reconfiguration and hot-plugging, see [Chapter 2](#), “Dynamically Configuring Devices”.

About InfiniBand Devices

InfiniBand (IB) is an I/O technology based on switched fabrics. It provides a high bandwidth and low latency interconnect for attaching I/O devices to hosts and for host-to-host communication. IB devices are managed by the Oracle Solaris IB nexus driver.

Oracle Solaris supports the following devices:

- IP over IB (IPoIB) devices – Enables transporting IP packets over IB connections. This feature is implemented by the `ibp` driver. For more information, see the [ibp\(4D\)](#) man page.
- Ethernet over IB (EoIB) – Enables transporting Ethernet frames over IB fabric.
- Socket Direct Protocol (SDP) – Supports sockets over IB.
- Reliable Datagram Service version 3 (RDSv3) and Reliable Datagram Service (RDS).
- NFS over Remote Direct Memory Access (NFSoRDMA) – Provides NFS services over IB using RDMA.
- iSCSI Extension for RDMA (iSER) – Provides RDMA data transfer capability to the iSCSI protocol.

- Open Fabric User Verb (OFUV).

Oracle Solaris Support for Infiniband Devices

Oracle Solaris now supports PCIe scalable system interface (PSIF) host channel adapter (HCA). For more information about PSIF, see the product notes in [Oracle Dual Port QDR InfiniBand Adapter M4 Documentation Library](#).

The IB nexus driver queries the Oracle Solaris IB Device Manager (IBDM) for communication services to enumerate the IB Port, HCA_SVC, and IB VPPA (virtual physical point of attachment) devices.

The IB partition link used for data transfers represents a new part class of data link that you manage by using `dladm` subcommands. You can create one IB partition link per each partition key (P_Key) on the port on top of an IB physical link.

Port devices bind a communication service to a specific port of a Host Channel Adapter (HCA). HCA_SVC devices bind a communication service to a specific HCA. VPPA devices bind a communication service to a combination of a port and a partition key (P_key). Note that port devices and HCA_SVC devices always use a partition key whose value is zero. Port, HCA_SVC, and VPPA devices are children of the HCA and are enumerated in the `ib.conf` file. For more information, see the [ib\(4D\)](#) man page.

Input Output Controller (IOC) devices are children of the IB nexus driver and are part of an I/O unit. Pseudo devices are also children of the IB nexus driver. This term refers to all other devices that provide their own configuration files to enumerate. For more information, see the [ib\(5\)](#) man page.

The possible IB device tree path names are as follows:

- IOC device – `/ib/ioc@1730000007F510C,1730000007F50`
- IB pseudo device – `/ib/driver@unit-address`
- IB VPPA device – `/pci@1f,2000/pci@1/pci15b3,5a44@0/ibport@,port#,P_key,service`
- IB HCA_SVC device –
- IB Port device – `/pci@1f,2000/pci@1/pci15b3,5a44@0/ibport@<port#>,0,service`
- HCA – `/pci@1f,2000/pci@1/pci15b3,5a44@0`

Note - For IB HCA_SVC devices, the port number and the value of `P_key` is zero.

The IB components that are part of the path names are:

<i>services</i>	A communication service. For example, <code>ipib</code> is the communication service used by the <code>ibd</code> kernel client driver.
<i>P_key</i>	The partition link key value.
<i>port</i>	The port number.
<i>unit-address</i>	The IB kernel client driver's unit address as specified in its <code>driver.conf</code> file. For more information, see the <code>driver.conf(5)</code> man page.

EoIB uses the services provided by the Oracle Solaris IB framework. However, EoIB is not a child of the IB nexus driver. Oracle Solaris EoIB is a single-instance pseudo device driver with a device tree path of `/pseudo/eib@0`. An EoIB datalink is a special `eoib` class of virtual links that is created and managed by `dladm` subcommands. You can create one EoIB datalink over an existing IB physical link for each EoIB Gateway discovered on the IB fabric from that IB physical link. To display a list of discovered EoIB Gateways, use the `dladm` subcommands.

For information about using IB diagnostic commands and utilities, see [“Monitoring and Troubleshooting IB Devices” on page 92](#).

InfiniBand Software Packages

The IB related software packages are as follows:

- `driver/infiniband/connectx` – Mellanox ConnectX Family InfiniBand HCA and 10GbE NIC drivers
- `system/io/infiniband/ethernet-over-ib` – Network device driver implementing Ethernet over InfiniBand
- `system/io/infiniband/ib-device-mgt-agent` – InfiniBand Device Manager Agent
- `system/io/infiniband/ib-sockets-direct` – InfiniBand layered Sockets Direct Protocol
- `system/io/infiniband/ip-over-ib` – Network device driver supporting the IP over InfiniBand (IPoIB) protocol
- `system/io/infiniband/open-fabrics` – Open Fabrics kernel components
- `system/io/infiniband/reliable-datagram-sockets-v3` – Reliable Datagram Sockets (RDSv3)
- `system/io/infiniband/reliable-datagram-sockets` – Reliable Datagram Sockets
- `system/io/infiniband/rpc-over-rdma` – InfiniBand RPC over RDMA Driver
- `system/io/infiniband` – InfiniBand Framework

- `driver/infiniband/sif` – Oracle PCIe Scalable System Interface (PSIF) InfiniBand HCA driver

Dynamically Reconfiguring IB Devices

You can configure or unconfigure an IB device on a system by using the `cfgadm` command. The command manages dynamic reconfiguration (DR) of the entire IB fabric as seen by a host. In addition, the command enables you to do the following:

- Display the IB fabric
- Manage communication services
- Update P_key table databases

For more information, see the [`cfgadm_ib\(8\)`](#) man page.

All IB devices such as Port, VPPA, HCA_SVC, IOC, and pseudo devices support `cfgadm` operations.

Note - When performing configuration procedures on IB devices, you must have the appropriate administrative privileges. For more information, see [“Using Your Assigned Administrative Rights”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

Displaying IB Device Information by Using the `cfgadm` Command

To display IB device information, use the following command syntax:

```
# cfgadm -[a]l
```

Including the `-a` option displays additional information.

The `cfgadm` command displays information about attachment points, which are locations in the system where DR operations can occur. Note that all IB Ap_Ids are shown as connected.

For more information, see [“Attachment Points”](#) on page 36. For more information about attachment points supported by the `cfgadm` command, see the [`cfgadm_ib\(8\)`](#) man page.

An attachment point consists of a receptacle and an occupant. The following table describes the state of a device depending on the corresponding combined states of the receptacle, occupant, and condition.

Receptacle/Occupant/Condition Combined State	Description
connected/configured/ok	The device is connected and available. The devinfo node is present.
connected/unconfigured/unknown	Either the device is unavailable and no devinfo node or device driver exists for this device or the device was never configured for use by <code>ib</code> nexus driver. The device might be known to the IB Device Manager.

The following sample output is truncated to show relevant IB information only.

```
# cfgadm -al
Ap_Id                Type                Receptacle          Occupant            Condition
ib                   IB-Fabric           connected           configured          ok
hca:21280001A0A478  IB-HCA              connected           configured          ok
ib::21280001A0A47A,0,ipib  IB-PORT            connected           configured          ok
ib::21280001A0A479,0,ipib  IB-PORT            connected           configured          ok
ib::1730000008070,0,hnfs  IB-HCA_SVC         connected           configured          ok
ib::daplt,0          IB-PSEUDO          connected           configured          ok
ib::iser,0           IB-PSEUDO          connected           configured          ok
ib::rdsib,0          IB-PSEUDO          connected           configured          ok
ib::rdsv3,0          IB-PSEUDO          connected           configured          ok
ib::rpcib,0          IB-PSEUDO          connected           configured          ok
ib::sdpib,0          IB-PSEUDO          connected           configured          ok
ib::sol_umad,0       IB-PSEUDO          connected           configured          ok
ib::sol_uverbs,0     IB-PSEUDO          connected           configured          ok
```

AP_Ids listed in the sample output are as follows:

```
ib::                Identifies an IB port device that is connected to port GUID and is bound
21280001A0A47A,    to the ipib service.
0,ipib

ib::sdpib,0        Identifies a pseudo device.

hca:                Identifies an HCA device.
21280001A0A478

ib::                Identifies an IB HCA_SVC device that is bound to the hnfs service.
1730000008070,0,
hnfs

ib::ibgen,0        Identifies a pseudo device.
```

The following examples show the use of selected `cfgadm` options that customize the command output.

EXAMPLE 18 Displaying Information About a Port Device

This example shows information about the port device `ib::21280001A0A47A,0,ipib`.

```
# cfgadm -al -s "cols=ap_id:info" ib::21280001A0A47A,0,ipib
Ap_Id                               Information
ib::21280001A0A47A,0,ipib          ipib
```

EXAMPLE 19 Displaying Port and GUID Information of an HCA Device

This example shows the number of ports and their respective GUIDs for the HCA device `hca:1730000008070`.

```
# cfgadm -al -s "cols=ap_id:info" hca:1730000008070
Ap_Id                               Information
hca:1730000008070                   VID: 0x15b3, PID: 0x5a44, #ports: 0x2,
port1 GUID: 0x1730000008071, port2 GUID: 0x1730000008072
```

EXAMPLE 20 Displaying Kernel Clients of an HCA Device

This example shows the kernel clients of the HCA `hca:173000007F50`.

```
$ cfgadm -x list_clients hca:173000007F50
Ap_Id                               IB Client           Alternate HCA
ib::1730000007F51D0                 ibgen               no
ib::1730000007F51D1                 ibgen               no
ib::1730000007F51,0,ipib           ibd                 no
ib::ibgen,0                         ibgen               no
-                                    ibdm                no
-                                    ibmf                no
-                                    nfs/ib              no
```

In the sample output, if a kernel IB client uses an HCA other than `hca:173000007F50`, the entry under the column `Alternate HCA` would indicate yes. If IB Managers and kernel clients that do not use the HCA, their `Ap_Ids` would not be listed. Moreover, although EoIB uses the Solaris IB framework, the command does not list EoIB as a kernel IB client.

EXAMPLE 21 Displaying Supported Communication Services

This example lists IB communication services currently used by the InfiniBand Transport Framework (IBTF).

```
# cfgadm -x list_services ib
Port communication services:
srp
```

```
VPPA communication services:
ibd
HCA_SVC communication services:
hnfs
```

EXAMPLE 22 Displaying IB Device Information by Using the `prtconf` Command

In addition to using the `cfgadm` command, you can also use the `prtconf` command to display general information about IB devices. In the following example, `pci15b3,673c` refers to an IB HCA.

```
$ prtconf
.
.
.
ib, instance #0
rpcib, instance #0
rdsib, instance #0
daplt, instance #0
rdsv3, instance #0
sdplib, instance #0
sol_umad, instance #0
sol_uverbs, instance #0
iser, instance #0
.
.
.
pci15b3,673c, instance #0
ibport, instance #0
ibport, instance #1
```

Configuring or Unconfiguring IB Devices

You use `cfgadm` subcommands to configure or unconfigure IB devices. The commands apply to IB port, HCA_SVC, or VPPA devices.

- To configure the IB device: `cfgadm -c configure device`
- To unconfigure the IB device: `cfgadm -c unconfigure device`

In both commands, the device is represented by its `Ap_Id`.

Note - To perform DR on HCAs, you use the bus-specific `cfgadm` plugin such as the `cfgadm_pci` command for a PCI-based HCA. For more information, refer to the appropriate man page, for example, the [`cfgadm_pci\(8\)`](#) man page.

A best practice is to display information about the system devices before and after configuring or unconfiguring a device. You can then properly identify the bus or device to dynamically reconfigure and verify from the state of the bus or device that the reconfiguration completed successfully.

The following examples show how to use the `cfgadm` command to perform DR on IB devices.

EXAMPLE 23 Configuring an IB Port Device

The following example configures the IB port device `ib::1730000007F51,*0*,ipib` and verifies that the operation was successful.

```
# cfgadm -c configure ib::1730000007F51,*0*,ipib
# cfgadm -a ib::1730000007F51,*0*,ipib
Ap_Id                Type      Receptacle Occupant  Condition
ib::1730000007F51,*0*,ipib IB-Port  connected  configured ok      The port device is
configured.
```

Note that if EoIB datalinks were configured over the IB Port when the port was previously unconfigured, you must re-create the VNICs corresponding to those EoIB datalinks on the EoIB gateway with the new IB HCA port GUIDs. You must re-create the vnics before re-configuring the IB Port. For information about how to create VNICs on the gateway, refer to the [Sun Network QDR InfiniBand Gateway Switch Administration Guide](#).

EXAMPLE 24 Unconfiguring an IB Port Device

This example unconfigures the IB port device `ib::1730000007F51,*0*,ipib` and verifies that the operation was successful.

```
# cfgadm -c unconfigure ib::1730000007F51,*0*,ipib
Unconfigure the device: /devices/ib:fabric::1730000007F51,*0*,ipib
This operation will suspend activity on the IB device
Continue (yes/no)? Y
# cfgadm -a ib::1730000007F51,*0*,ipib
Ap_Id                Type      Receptacle Occupant  Condition
ib::1730000007F51,*0*,ipib IB-Port  connected  unconfigured unknown  The port device is
unconfigured.
```

EXAMPLE 25 Configuring an IB Pseudo Device

This example configures the pseudo device `ib::ibgen,0` and verifies that the operation was successful.

```
# cfgadm -yc configure ib::ibgen,0
# cfgadm -a ib::ibgen,0
Ap_Id                Type          Receptacle Occupant  Condition
ib::ibgen,0         IB-PSEUDO    connected  configured ok    The device is configured.
```

EXAMPLE 26 Unconfiguring an IB Pseudo Device

This example unconfigures the pseudo device `ib::ibgen,0` and verifies that the operation was successful.

```
# cfgadm -c unconfigure ib::ibgen,0
Unconfigure the device: /devices/ib:fabric::ibgen,0
This operation will suspend activity on the IB device
Continue (yes/no)? Y
# cfgadm -a ib::ibgen,0
Ap_Id                Type          Receptacle Occupant  Condition
ib::ibgen,0         IB-PSEUDO    connected  unconfigured unknown    The device is unconfigured.
```

Modifying IB Configurations

This section describes how to modify existing IB configurations by supplying hardware option or hardware function information. The format and content of this information is hardware specific. You use the following `cfgadm` command options to supply the modification information:

- `cfgadm -o hardware-options` – Supplies hardware-specific options. The format and content of the hardware option string is completely hardware specific.
- `cfgadm -x hardware-functions` – Performs hardware-specific functions. Private hardware-specific functions can change the state of a receptacle or occupant. Attachment point conditions can change as the result of errors encountered during private hardware specific functions.

Updating the IB P_key Tables

When you enable additional P_keys or disable them, the P_key table information of an HCA's port changes. For consistency, corresponding updates must also occur in the internal P_key databases of the InfiniBand Transport Framework (IBTF) and IBDM.

EXAMPLE 27 Updating the IB P_key Databases

This example shows how to update the P_key databases of IBTF and IBDM.

```
# cfgadm -x update_pkey_tbls -y ib
```

For more information, see the [ibtl\(4D\)](#) and [ibdm\(4D\)](#) man pages.

Adding and Removing Communication Services

You can add and remove communication services by using the `cfgadm` command options.

- To add communication services:

```
cfgadm -o comm=vppa,service=svc-name -x add_service ib
```

- To delete communication services:

```
# cfgadm -o comm=vppa,service=svc-name -x add_service ib
```

EXAMPLE 28 Adding a VPPA Communication Service

This example adds a VPPA communication service to the IB device and verifies that the operation was successful.

```
# cfgadm -o comm=vppa,service=newsvc -x add_service ib
# cfgadm -x list_services ib
Port communication services:
srp
VPPA communication services:
ibd
newsvc
HCA_SVC communication services:
nfs_service
```

EXAMPLE 29 Removing an Existing VPPA Communication Service

This example removes the newsvc communication service that was added in [Example 28, “Adding a VPPA Communication Service,”](#) on page 80, and verifies that the operation was successful.

```
# cfgadm -o comm=vppa,service=comm1 -x delete_service ib
# cfgadm -x list_services ib
Port communication services:
srp
VPPA communication services:
ibd
HCA_SVC communication services:
hnfs
```

Administering IPoIB Devices

For every HCA, one physical data link per port is created by default. You can use the physical links as administrative and observable data points. You can create IB partition links over the physical data links, similar to creating VNICs over a NIC. Because physical data links are not used for data transfers, plumbing and assigning IP addresses is not supported on these links. Data is transferred on the partition data links.

For information about configuring your network components, see [Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.4](#).

Displaying Physical Data Link Information

The physical link state directly corresponds to the IB HCA port state.

Note - The output samples in the examples in this section are truncated to show only information relevant to InfiniBand.

To display physical data link information, use the following commands:

- `dladm show-phys [link]`

If you do not specify a value for *link*, information about all the links is displayed.

This command displays basic information about links on the system such as the media type, the current state, and the speed capacity. The same command is used to display information about links of other media types.

```
# dladm show-phys
LINK      MEDIA      STATE      SPEED      DUPLEX      DEVICE
ibp0     Infiniband  up         8000      unknown    ibp0
ibp1     Infiniband  down       8000      unknown    ibp1
ibp2     Infiniband  down       8000      unknown    ibp2
ibp3     Infiniband  up         8000      unknown    ibp3
```

- `dladm show-ib [link]`

If you do not specify a value for *link*, information about all the links is displayed.

This command displays the physical links, port GUIDs, port, HCA GUIDs, the P_Keys present on the port at the time the command is running, and the EoIB gateways that are discovered from each IB port.

The following example shows four gateway Ethernet ports discovered from the IB HCA port `ibp1`. All four are on the gateway `nm2gw-1`.

```
# dladm show-ib
LINK      HCAGUID      PORTGUID      PORT STATE GWNAME  GWPORT  PKEYS
ibp0     212800013F2F5A 212800013F2F5B 1   down  --      --      FFFF
ibp1     212800013F2F5A 212800013F2F5C 2   up    nm2gw-1 0a-eth-1 FFFF,8001
                                     nm2gw-1 0a-eth-2
                                     nm2gw-1 0a-eth-3
                                     nm2gw-1 0a-eth-4
```

Creating and Removing IB Partition Links

You can create one or more IB partition data links on top of IB physical links with the same P_Key. You use the partition data links for data transfers.

Use the following command syntax to create an IB partition link:

```
# dladm create-part -l link -P key partition
```

link Name of the physical data link

key Value of the partition key (P_key)

partition Name of the partition link using the format *P_key.link*

The command assumes that the port is up, the P_Key is present on the port, and IPoIB is successfully initialized. If these three conditions do not exist, the command fails.

Note - Even if the conditions do not exist, you can still create a partition link by using the `-f` option. If the partition key is not configured on the port or the port is marked as down, use the following command:

```
# dladm create-part -f -l link -P key name
```

In this case, the link state transitions to up when the partition key is added to the port and the port is activated.

▼ How to Create IB Partition Links

1. **Become an administrator.**
2. **Create new IB partition links.**

```
# dladm create-part -l link -P key partition
```

link Name of the physical data link.

key Value of the partition key (P_key).

partition Name of the partition link and using the format *P_key.link*

The command assumes that the port is up, the P_Key is present on the port, and IPoIB is successfully initialized. If these three conditions do not exist, the command fails.

3. **Display the IB partition link information.**

```
# dladm show-part
```

4. **Plumb and assign an IP address to an IB partition link.**

```
# ipadm create-ip name
```

```
# ipadm create-addr -a address [address-object]
```

name Name of the partition link.

address A valid IP address. By default, this address is assumed to be a static address.

address-object A name that identifies the IP address in association with the IP interface. If *address-object* is not specified, the OS automatically assigns a name using the format *IP-name/protocol*

For more information about the `ipadm` command, see the [ipadm\(8\)](#) man page.

Example 30 Configuring a Partition Link

This example shows how to configure a partition link. It creates partition links over the physical links `ibp0` and `ibp2` and configures on IPoIB interface over `ibp2`.

The values of `P_key` are `0x8001` for `ibp0` and `0x9000` for `ibp2`.

```
# dladm create-part -l ibp0 -P 0x8001 p8001.ibp0
# dladm create-part -l ibp2 -P 0x9000 p9000.ibp2

# dladm show-part
LINK          P_Key      OVER      STATE      FLAGS
p8000.ibp0    8001      ibp0      unknown    ----
p9000.ibp2    9000      ibp2      unknown    ----

# ipadm create-ip p9000.ibp2
# ipadm create-addr -a 1.1.1.1 p9000.ibp2/ipv4
# ipadm show-addr
ADDRJOB      TYPE      STATE      ADDR
p9000.ibp2/ipv4  static    ok         1.1.1.1/24

# dladm show-part
LINK          P_Key      OVER      STATE      FLAGS
p8000.ibp0    8001      ibp0      unknown    ----
p9000.ibp2    9000      ibp2      up         ----
```

▼ How to Remove an IB Partition Link

Before You Begin Make sure that no IPoIB interface is configured over the partition link. If an interface exists, remove it first.

1. **Become an administrator.**
2. **Remove the IB partition link.**

```
# dladm delete-part partition
```

In this example, the partition link `p8001.ibp0` is removed after ensuring that it has no existing interface.

```
# dladm delete-part p8001.ibp0
```

3. **Review the partition link information.**

The following example shows the remaining partition link on the system after `p8001.ibp0` is removed.

```
# dladm show-part
LINK          P_Key      OVER      STATE      FLAGS
p9000.ibp2    9000       ibp2      down       f---
```

Identifying the Link Status of IB Partition Links

IB partition links can be down in any of following scenarios:

- HCA port is down
- Partition key is not present
- IB partition link fails to join the broadcast multicast group

You can use the `dladm show-ib` command to check the HCA port status and the configured partition key. To check if the IB partition link has failed to join the broadcast multicast group, display the `broadcast-group datalink` property of the IB partition link by using the `dladm show-linkprop` command. The valid values of this read-only datalink property are `unknown`, `joined`, `assigned`, and `unsuccessful`, and the default value is `unknown`.

EXAMPLE 31 Identifying the Status of an IB Partition Link

This example shows to how to find the link state of an IB partition link.

```
# dladm show-ib net1
LINK HCAGUID          PORTGUID          PORT STATE GWNAME GWPORT PKEYS
net4 21290001A0A58C 21280001A0A59D 1   up   --   --   FFFF
# dladm create-part -l net1 -P ffff ibd0
# dladm show-linkprop -p broadcast-group ibd0
LINK PROPERTY          PERM VALUE    EFFECTIVE DEFAULT POSSIBLE
ibd0 broadcast-group r-   unknown unknown  unknown unknown
                                absent,
                                joined,
                                unsuccessful
```

Before you create the IP instance, the value of the `broadcast-group` property is `unknown`.

```
# dladm create-ip ip_ibd0
# dladm show-linkprop -p broadcast-group ip_ibd0
LINK PROPERTY          PERM VALUE    EFFECTIVE DEFAULT POSSIBLE
ibd0 broadcast-group r-   joined  joined  unknown unknown
                                absent,
```

```
joined,  
unsuccessful
```

After the IP instance is created, the value of the broadcast-group property is displayed as joined.

```
# ipadm delete-ip ibd0  
# dladm show-linkprop -p broadcast-group ibd0  
LINK PROPERTY      PERM VALUE  EFFECTIVE DEFAULT POSSIBLE  
ibd0 broadcast-group r-   absent    unknown  unknown unknown  
                                     absent,  
                                     joined,  
                                     unsuccessful
```

If you delete the IP instance, then the broadcast-group property is shown as absent.

The broadcast-group property displays the value `unsuccessful` when the broadcast group is configured but IPoIB fails to join the broadcast group.

Administering EoIB Datalinks

You can also use the per IB-port physical datalinks described in [“Administering IPoIB Devices” on page 81](#) as administrative end points for EoIB datalinks.

Creating and Removing EoIB Datalinks

Starting with the Oracle Solaris 11.2, release, you can create an EoIB datalink as a special `eoib` class object over an IB physical link using the `dladm create-eoib` command. These `eoib` class EoIB datalinks can host Ethernet data transfers just as regular Ethernet datalinks do. Additionally, you can also build VNICs and VLANs over these EoIB datalinks by using the `dladm create-vnic` and `dladm create-vlan` commands.

Note - EoIB datalinks can be created arbitrarily on Oracle Solaris. However, for data transfers to be successful, a Sun Network QDR InfiniBand Gateway Switch must be properly configured on the InfiniBand fabric. For information about configuring the gateway, see the [Sun Network QDR InfiniBand Gateway Switch Administration Guide](#).

For information about configuring the network components, see [Configuring and Managing Network Components in Oracle Solaris 11.4](#).

▼ How to Create and Configure an EoIB Datalink

1. **Become an administrator.**
2. **Display information about a chosen IB physical link.**

```
# dladm show-ib link
```

If the output shows that the link's port is down, you can still proceed with the datalink creation and configuration. Then when the causes of the down state are resolved, the datalink will automatically transition to the up state. For more information about the information that this command displays, see [“Displaying Physical Data Link Information” on page 81](#).

3. **Create a new EoIB datalink and bind the host IB port to the Ethernet port on the EoIB gateway.**

```
# dladm create-eoib -l link -g gway -c gway-port eoib-link
```

link Name of the physical link.

gway Gateway name.

gway-port Gateway Ethernet port.

eoib-link Name of the EoIB datalink.

4. **Create an IP interface over the datalink and assign an IP address to the interface.**

```
# ipadm create-ip name
# ipadm create-addr -a address [address-object]
```

name Name of the EoIB interface.

address A valid IP address. By default, this address is assumed to be a static address.

address-object A name that identifies the IP address in association with the IP interface. If *address-object* is not specified, the OS automatically assigns a name using the format *name/protocol*.

5. **(Optional) Display the interface information.**

```
# ipadm show-addr
```

6. **Display the EoIB datalink information.**

You can use either the standard `show-link` subcommand for more general information or the `show-eoib` subcommand for more specific IB-related information.

```
# dladm show-link [eoib-link]
```

```
# dladm show-eoib [eoib-link]
```

For sample output, see [Example 33, “Displaying EoIB Datalink Information,”](#) on page 88.

Example 32 Creating and Configuring an EoIB Datalink

In this example, an EoIB link is configured over `ibp1`.

```
# dladm show-ib ibp1
LINK      HCAGUID          PORTGUID          PORT STATE GWNAME  GWPORT  PKEYS
ibp1     212800013F2F5A  212800013F2F5C  1   up     nm2gw-1 0a-eth-1 FFFF,8001
                               nm2gw-1 0a-eth-2
                               nm2gw-1 0a-eth-3
                               nm2gw-1 0a-eth-4

# dladm create-eoib -l ibp1 -g nm2gw-1 -c 0a-eth-2 eib1

# ipadm create-ip eib1
# ipadm create-addr -a=192.0.2.35/27
# ipadm show-addr eib1
ADDROBJ   STATE   TYPE   ADDR
eib1/v4   static  ok     192.0.2.35.27

# dladm show-link eib1
LINK  CLASS  MTU   STATE  OVER
eib1  eoib   1500  up     ibp1

# dladm show-eoib eib1
LINK  GWNAME  GWPORT  GWID  FLAGS  SPEED  MACADDRESS  OVER
eib1  nm2gw-1 0a-eth-2 1A8   aHnU-- 10000  0:25:8b:60:2:3  ibp1
```

Example 33 Displaying EoIB Datalink Information

This example shows typical output of the `dladm show-eoib` command.

```
LINK  GWNAME  GWPORT  GWID  FLAGS  SPEED  MACADDRESS  OVER
eib1  nm2gw-1 0a-eth-2 1A8   aHnU-- 10000  0:25:8b:60:2:3  ibp1
```

The GWID value `1A8` is the unique identifier associated with the gateway and Ethernet port `{nm2gw-1, 0a-eth-2}` on the IB fabric. The MAC address is the address specified as a parameter when the VNIC associated with this datalink was created on the gateway. For more information about the output, see the [dladm\(8\)](#) man page.

The VNIC in this context refers to the entity created on the gateway switch using the `createvnic gateway` command. This VNIC is different from the entity that is created with Oracle Solaris `dladm` subcommands.

For more information about the `createvnic` command, see the [Sun Network QDR InfiniBand Gateway Switch Command Reference](#).

▼ How to Remove an EoIB Datalink

You can remove an existing EoIB datalink that has no IP interfaces, VLANs, or VNICs currently built over it.

1. **Become an administrator.**
2. **List the EoIB datalinks to identify the EoIB datalink to remove.**
3. **Verify that no VNICs, VLANs, and IP interfaces are built over the EoIB datalink.**

```
# dladm show-eoib
```

```
# dladm show-vlan link
# dladm show-vnic -l link
# dladm show-if interface
```

where *link* is the EoIB datalink you want to remove and *interface* is the IP interface that might be configured over the EoIB datalink. Typically, the interface name is identical with the datalink name over which the interface is created.

4. **Remove any interfaces built over the EoIB datalink.**
5. **Remove the EoIB datalink.**
6. **Verify that the EoIB datalink is removed.**

```
# ipadm delete-ip interface
```

```
# dladm delete-eoib link
```

```
# dladm show-eoib link
```

Example 34 Removing an EoIB Datalink

In this example, the IP interface is first removed from the datalink `eib1` before the datalink itself is removed. No VLANs nor VNICs are configured over the link.

```
# dladm show-eoib eib1
LINK      GWNAME  GWPORT  GWID  FLAGS  SPEED  MACADDRESS  OVER
eib1     nm2gw-1 0a-eth-2 1A8   aHnU-- 10000  0:25:8b:60:2:3  ibp1

# dladm show-vlan eib1
dladm: failed to show vlan eib1: object not found
# dladm show-vnic -l eib1
    no output generated
# ipadm show-if eib1
IFNAME  CLASS  STATE  ACTIVE  OVER
eib1    ip     ok     yes     --

# ipadm delete-ip eib1
# dladm delete-eoib eib1
# dladm show-eoib eib1
dladm: non-existent datalink 'eib1'
```

Restoring Partially Migrated EoIB Datalinks

EoIB datalinks in previous Oracle Solaris releases existed as phys class datalinks similar to regular Ethernet datalinks. If you upgrade to Oracle Solaris 11.2, existing EoIB datalinks on the system are automatically migrated to the new eoib class datalinks.

If you also plan to upgrade the gateway firmware, upgrade the OS first to ensure the proper migration of the Oracle Solaris EoIB instances to the new datalink class. Then, upgrade the gateway firmware.

Note - Automatic migration succeeds partially if the original gateway Ethernet port instances corresponding to the existing phys class datalinks are unavailable at the time of the upgrade. You must complete the migration manually.

▼ How to Restore an EoIB Datalink That Failed During Migration

1. **Become an administrator.**
2. **Identify any EoIB datalink that has not been fully migrated.**

```
# dladm show-eoib
```

Information would be missing for datalinks that have not successfully migrated, as shown in the following example:

```
# dladm show-eoib
```

```
LINK  GWNAME GWPORT GWID  FLAGS  SPEED  MACADDRESS  OVER
eib2  ?       ?       1A8  ----- 10000  0:0:0:0:0:0  ibp1
```

3. Determine the gateway system name and Ethernet port corresponding to the GWID.

The gateway/IB fabric administrator can determine this information from knowledge of the configuration and by using appropriate tools on the gateway.

4. Delete any existing VNICs, VLANs, or IP interfaces that might have been configured over the datalink.

5. Delete the partially migrated EoIB datalink.

```
# dladm delete-eoib link
```

6. Re-create the EoIB datalink with the correct information.

```
# dladm create-eoib -l link -g gway -c gway-port eoib-link
```

link Name of the physical link.

gway Gateway name.

gway-port Gateway Ethernet port.

eoib-link Name of the EoIB datalink.

7. Re-create any VNICs, VLANs, or IP interfaces that you removed.

Example 35 Restoring an EoIB Datalink That Failed Migration

In this example, eib2 did not completely migrate. eib2 had the following configuration prior to the migration:

- eib2 was configured over the physical link ibp1.
- The GWID is 1A8.
- The gateway name is nm2gw-2.
- The gateway port is 0a-eth-1.

After determining that all existing configurations over eib2 have been deleted, delete the EoIB and re-create it with the correct information.

```
# dladm delete-eoib eib2
```

```
# dladm create-eoib -l ibp1 -g nm2gw-2 -c 0a-eth-1 eib2
```

Monitoring and Troubleshooting IB Devices

The Oracle Solaris 11.4 release provide commands and utilities that enable you to manage the IB fabric more effectively. These commands are included in the `system/io/infiniband/open-fabrics` package.

The commands and utilities described in the following table enable you to list and query IB devices.

TABLE 1 General IB Monitoring Commands

Command	Description
<code>ibv_asyncwatch</code>	Monitors InfiniBand asynchronous events
<code>ibv_devices</code> or <code>ibv_devinfo</code>	Lists InfiniBand devices or device information
<code>ibv_rc_pingpong</code> , <code>ibv_srq_pingpong</code> , or <code>ibv_ud_pingpong</code>	Tests node to node connectivity by using an RC connection, SRQs, or a UD connection
<code>mckey</code>	Tests the RDMA CM multicast setup and simple data transfer
<code>rping</code>	Tests the RDMA CM connection and attempts an RDMA ping-pong test
<code>ucmatose</code>	Tests RDMA CM connection and attempts a simple ping-pong test
<code>udaddy</code>	Tests RDMA CM datagram setup and attempts a simple ping-pong test

The following table describes commands used for general IB performance testing.

TABLE 2 General IB Performance Testing Commands

Command	Description
<code>rdma_bw</code> or <code>rdma_lat</code>	Tests RDMA write transactions for streaming bandwidth or latency.
<code>ib_read_bw</code> or <code>ib_read_lat</code>	Tests RDMA read transactions for bandwidth or latency.
<code>ib_send_bw</code> or <code>ib_send_lat</code>	Tests RDMA send transactions for bandwidth or latency.
<code>ib_write_bw</code> or <code>ib_write_bw_postlist</code>	Tests RDMA write transactions for bandwidth that displays one I/O request at a time or post list bandwidth that displays a list of I/O requests.
<code>ib_write_lat</code>	Tests RDMA write transactions for latency.
<code>ib_clock_test</code>	Tests the accuracy of the system clock
<code>qperf</code>	Measures socket and RDMA performance

The following table describes RDS monitoring and testing tools.

TABLE 3 RDS Monitoring and Testing Tools

Command	Description
rds-info	Displays RDS kernel module information
rds-ping	Determines whether the remote node over RDS is reachable
rds-stress	Sends a message between processes over RDS sockets

Note that RDSv3 does not support unconfiguring HCAs. If the system has an RDSv3 driver installed at the time of DR, unconfiguring the HCA fails with an error message such as the following example for `ib::rdsv3,0`.

```
# cfgadm -c unconfigure ib::rdsv3,0
This operation will suspend activity on the IB device
Continue (yes/no)? yes
cfgadm: Hardware specific failure: unconfigure operation
failed ap_id: /devices/ib:fabric::rdsv3,0

# cfgadm -c unconfigure PCI-EM0
cfgadm: Component system is busy, try again: unconfigure failed
```

Workaround:

Remove the RDSv3 driver and reboot the system before performing the HCA DR operation.

```
# rem_drv rdsv3
Device busy
Cannot unload module: rdsv3
Will be unloaded upon reboot.

# init 6
```

The following table describes fabric diagnostic tools.

TABLE 4 Fabric Diagnostic Tools

Command	Description
ibdiagnet	Performs a diagnostic check of the entire fabric
ibaddr	Queries an InfiniBand address or addresses
ibnetdiscover	Discovers remote InfiniBand topology
ibping	Validates connectivity between IB nodes
ibportstate	Queries the physical port state and link speed of an IB port
ibroute	Displays InfiniBand switch forwarding tables

Command	Description
ibstat or ibsysstat	Queries the status of an InfiniBand device or devices or the status of a system on an IB address
ibtracert	Traces an IB path
perfquery or saquery	Queries IB port counters or sIB subnet administration attributes
sminfo	Queries the IB SMInfo attribute
smpquery or smpdump	Queries or dumps IB subnet management attributes
ibcheckerrors or ibcheckerrs	Validates the IB port (or node) or IB subnet and reports errors
ibchecknet, ibchecknode, or ibcheckport	Validates the IB subnet, node or port and reports errors
ibcheckportstate, ibcheckportwidth, ibcheckstate, or ibcheckwidth	Validates IB ports that are linked up but not active, ports for 1x (2.0 Gbps) link width, ports in the IB subnet that are linked up but not active, or lx links in the IB subnet
ibclearcountersibclearerrors or ibclearerrors	Clears port counters or error counters in the IB subnet
ibdatacounters, or ibdatacounts	Queries for data counters in the IB subnet or IB port data counters
ibdiscover.pl	Annotates and compares IB topology
ibhosts	Displays IB host nodes in the IB topology
iblinkinfo.pl or iblinkinfo	Displays link information for all links in the fabric
ibnodes	Displays IB nodes in the topology
ibprintca.pl	Displays either the CA specified or the list of CAs from the ibnetdiscover output
ibprintrt.pl	Displays either the specified router or a list of routers from the ibnetdiscover output
ibprintswitch.pl	Displays either the specified switch or a list of switches from the ibnetdiscover output
ibqueryerrors.pl	Queries and reports non-zero IB port counters
ibrouters	Displays IB router nodes in the topology
ibstatus	Queries the basic status of IB devices
ibswitches	Displays IB switch nodes in the topology
ibswportwatch.pl	Polls the counters on the specified switch or port and reports the rate of change information
set_nodedesc.sh	Sets or displays the node description string for IB Host Controller Adapters (HCAs)
dump2psl.pl	Dumps the PSL file based on the opensm output file that is used for credit loop checking
dump2slvl.pl	Dumps the SLVL file based on the opensm output file that is used for credit loop checking
ibis	An extended TCL shell for IB management in-band services

Note - The fabric diagnostic tools mentioned in the table are not supported from virtual functions (VFs).

◆◆◆ CHAPTER 4

Managing Disks in Oracle Solaris

Disk management involves a range of tasks from creating appropriate disk slices and file systems during an Oracle Solaris installation to adding or replacing disks. This chapter provides overview information about managing disks on the system. It covers the following topics:

- “Disk Management Features” on page 97
- “Oracle Solaris Disk Management Concepts and Terminology” on page 100
- “Disk Management Task Information” on page 102

For instructions about how to add a disk to your system, see [Chapter 7, “Setting Up ZFS on Disks”](#).

Disk Management Features

This section describes features in Oracle Solaris for managing disks on your system.

Installing on Large Disks

You can install and boot Oracle Solaris from a disk that is up to 2 TB in size. This support applies to the following systems:

- SPARC platforms with an updated OBP. Note that the SPARC boot loader remains unchanged.
- x86 platforms that use GRUB 2 as the default system boot loader.

On both system types, the 2-terabyte disk must be connected to a system with a minimum of 1.5 GB of memory.

With EFI (GPT) partitioning, all of the disk space on the boot device can be used for Oracle Solaris installations.

For more information, see [Chapter 2, “Administering the GRand Unified Bootloader” in *Booting and Shutting Down Oracle Solaris 11.4 Systems*](#).

Disk management utilities now accommodate this feature. For example, the `fdisk` utility can support partitions of up to 2 TB. However, limits might be imposed on other non-EFI partitions. A warning will appear if you attempt to run the utility on a disk that is larger than 2 TB.

Note - You cannot move a disk over 1 TB with a legacy MBR or a legacy VTOC to a system running a release prior to Oracle Solaris 11.4. EFI-labeled disks continue to work as in releases prior to Oracle Solaris 11.4.

Using Whole Disks for a ZFS Root Pool Disk or Disks

The Oracle Solaris installation program can install an EFI (GPT) disk label on a ZFS root pool disk or disks by using the DVD, USB, and automated installation methods. UEFI firmware support and the introduction of GRUB 2 provide the ability to boot from a GPT labeled disk. You can therefore use whole disks for a ZFS root pool disk or disks on the following platforms:

- SPARC based systems with GPT enabled firmware
- Most x86 based systems, which are UEFI compliant

Note - For more information about disk labels, see [“About EFI \(GPT\) Disk Labels” on page 100](#).

Note the following information about root pool disks:

- On SPARC based systems, the root file system is contained in slice 0. On x86 based systems, the root file system is contained in partition 1.
- The `zpool` command can support EFI (GPT) labels.
- To re-create a root pool or create an alternate root pool, use the `zpool create -B` command. The command option creates the required slices and information for booting.

If you use the `zpool replace` command to replace a disk in a root pool that has an EFI (GPT) labeled disk, you must also reinstall the boot loader.

Using Advanced Format Disks

Oracle Solaris can support advanced format (AF) disks, which are hard disk drives that exceed the traditional 512-byte block size.

AF disks are generally in the 4 KB block size range, but vary as follows:

- A 4 KB native disk (4kn) has a physical and logical block size of 4 KB
- A 512-byte emulation (512e) has a physical block size of 4 KB but reports a logical block size of 512 bytes

Oracle Solaris also supports the 512-byte native (512n) disk, which is a traditional disk with 512-byte block size.

You can create a ZFS file system or a PCFS file system on a 4kn disk. You can also boot a ZFS file system on a 4kn disk that is labeled with EFI (GPT) on both SPARC-based and x86-based systems.

Note - You cannot boot a 4kn disk on an x86-based system with a legacy BIOS.

Before purchasing advanced format drives, confirm with your device manufacturer that their 512e devices have a power-safe feature. This feature prevents data loss after a power failure while data is still in transit.

To determine whether your system has AFD-supported disks, use the `devprop` command.

```
# devprop -n device-path
```

The following examples show the command output for different disk types.

- For a 4 Kb native disk:

```
# devprop -n /dev/rdisk/c0t0d0s0 device-blksize device-pblksize
4096
4096
```

- For a 512n disk:

```
# devprop -n /dev/rdisk/c1t0d0s0 device-blksize device-pblksize
512
512
```

- For a 512e disk:

```
# devprop -n /dev/rdisk/c2t0d0s0 device-blksize device-pblksize
512
4096
```

iSNS Support in the Oracle Solaris iSCSI Target and Initiator

Oracle Solaris provides support for the Internet Storage Name Service (iSNS) protocol in the Oracle Solaris iSCSI target and initiator software. The iSNS protocol enables automated discovery, management, and configuration of iSCSI devices on a TCP/IP network.

For information about configuring the Oracle Solaris iSCSI target to use a third-party iSNS server, see [Chapter 8, “Configuring Storage Devices With COMSTAR”](#).

For information about configuring the Oracle Solaris iSCSI target for an Oracle Solaris iSNS server, see [Chapter 9, “Configuring and Managing the Oracle Solaris Internet Storage Name Service \(iSNS\)”](#).

Identifying Devices by Physical Locations

The `/dev/chassis` directory contains device names that include physical locations. This information can help you identify where devices are physically located if they need to be replaced or changed. For a list of commands that display disk information as well as examples to obtain physical location information, see [“Displaying Disk Physical Locations” on page 123](#).

Oracle Solaris Disk Management Concepts and Terminology

This section describes concepts that are useful to understand disk management in Oracle Solaris.

About EFI (GPT) Disk Labels

A disk *label* stores information about the disk's controller, geometry, and slices. A disk label is also called the *VTOC (Volume Table of Contents)* label.

Labeling a disk means writing slice information onto the disk. You usually label a disk after you change its slices or partitions. The OS uses the label to obtain information about the slices. If you fail to label a disk after you create slices, the slices will be unavailable.

Oracle Solaris supports the following disk labels:

- SMI – Traditional VTOC label for disks that are smaller than 2 TB.

- EFI – Label for disks that are larger than 2 TB. However, the Extensible Firmware Interface GUID Partition Table (EFI GPT) disk label is also available for disks smaller than 2 TB.

Note - You can continue to use the VTOC label on any size disk, but the addressable space by the VTOC is limited to 2 TB.

In Oracle Solaris, an EFI (GPT) labeled disk is installed by default on the following systems:

- SPARC systems with GPT enabled firmware
 - On SPARC T4 servers, the Sun System Firmware must be at least version 8.4.0. On SPARC T5 and SPARC M5 servers, the firmware must be at least version 9.1.0. On Fujitsu M10 servers, the firmware must be at least version XCP 2230 or later.
- x86 systems

The Oracle Solaris ZFS file system supports file systems that are larger than 1 TB.

Note - The legacy Oracle Solaris Volume Manager software can also be used to manage disks that are larger than 1 TB, but you cannot use a root disk that is managed by Oracle Solaris Volume Manager for booting Oracle Solaris 11.4.

The following additional features differentiate the EFI disk label from the VTOC disk label:

- Provides usable slices 0-6, where partition 2 is just another slice.
- Prohibits overlap of partitions or slices with a primary or backup label, or with other partitions. The size of the EFI label is usually 34 sectors, so partitions usually start at sector 34. No partition can start at sector zero (0). The entire disk is represented by `cxtydz`.
- Does not use the notion of geometry. Partitions in EFI (GPT) labeled disks are defined based on logical blocks. Therefore, the EFI disk label provides information about disk or partition sizes in sectors and blocks but not in cylinders and heads.
- Stores information in the last two cylinders of a disk or partition instead of in an alternate cylinder area.
- Supports reassigning partition tags after partition sizes are changed. However, note that the unassigned partition tag is assigned only to partitions with sizes equal to zero.

Before deciding to use EFI disks, consider that layered software products that are intended for systems with VTOC-labeled disks might be incapable of accessing a disk with an EFI disk label.

About Disk Slices or Partitions

Files on a disk are contained in file systems. Each file system on a disk is assigned to a *slice* composed of a group of sectors. Certain interfaces, such as the `format` utility, refer to slices as *partitions*.

Each disk slice appears as a separate disk drive.

When setting up slices, note these rules:

- Each disk slice holds only one file system.
- No file system can span multiple slices.

For information about file systems, see [Managing File Systems in Oracle Solaris 11.4](#).

Note - Third-party database applications typically create raw data slices. These applications must not use block 0 or slice 2 for raw slices. Block 0 stores the disk label while slice 2 represents the entire disk with a VTOC label. Creating raw slices on these two locations overwrites the disk label and renders data on the disk inaccessible.

Using the Free Hog Slice

When you use the `format` utility to change the size of one or more disk slices, you designate a temporary slice that will expand and shrink to accommodate the resizing operations.

This temporary slice donates, or "frees", space when you expand a slice, and receives, or "hogs", the discarded space when you shrink a slice. For this reason, the donor slice is sometimes called the *free hog* slice.

The free hog slice exists only during installation or when you run the `format` utility. There is no permanent free hog slice during day-to-day operations.

For information about using the free hog slice, see ["How to Replace a ZFS Root Pool Disk" on page 143](#).

Disk Management Task Information

- Display physical disk information – ["Obtaining Disk Information" on page 116](#)
- Configure disks – ["Configuring Disks" on page 124](#)

- Display information about disk usage – [“Managing Disk Use” on page 105](#)
- Set up ZFS pools on disks – [Chapter 7, “Setting Up ZFS on Disks”](#)
- Hot-plug a SCSI or PCI disk – [Chapter 2, “Dynamically Configuring Devices”](#)

Managing the Use of System Disks

This chapter describes how to optimize disk space by locating unused files and large directories. It covers the following topics:

- [“Managing Disk Use” on page 105](#)
- [“Displaying Information About Disk Space” on page 106](#)
- [“Displaying Information About File Sizes” on page 107](#)
- [“Displaying Information About Directory Sizes” on page 109](#)
- [“Maintaining Disks” on page 110](#)

Managing Disk Use

This chapter describes how to manage disk use. The following task map points to the management tasks you can perform on disks.

TABLE 5 Managing Disk Use Task Map

Task	Description	For Instructions
Display information about the use of disk space on the system.	Show how disk space is currently being used.	“Displaying Information About Disk Space” on page 106
Display information about sizes of files that use up disk space.	Shows sizes and other information about files that are stored on the system disks.	“Displaying Information About File Sizes” on page 107
Display information about the size of directories and subdirectories.	Displays the size of one or more directories, subdirectories, and files by using the <code>du</code> command.	“Displaying Information About Directory Sizes” on page 109
Perform disk maintenance.	Ensure sdisk availability by regularly removing unnecessary files and directories. Identifies old files by listing them based on time stamps.	“Maintaining Disks” on page 110
Find and remove old or inactive files.	Uses the <code>find</code> to identify inactive files that can be marked for deletion.	“Removing Old or Inactive Files” on page 110

Task	Description	For Instructions
Clear out temporary directories.	Locates temp directories, then uses the <code>rm -r *</code> command to remove the entire directory.	“Emptying Temporary Directories” on page 112
Find and delete core files.	Finds and deletes core files by using the <code>find . -name core -exec rm {} \;</code> command.	“Removing Dump Files” on page 112

Displaying Information About Disk Space

The command you use to obtain information about the use of disk space on your system depends on the file system. The following sections show how to use the appropriate command for the file system to display data about disk use.

Displaying the Use of Disk Space on ZFS File Systems

To display information about how ZFS disk space is used, use the `zpool` command.

```
# zpool list root-pool
```

where *root-pool* is the name of the root pool on the system. The following example provides information about `rpool`, which has 10.0 Gbytes allocated and 580 Gbytes free.

```
# zpool list rpool
NAME  SIZE  ALLOC  FREE  CAP  HEALTH  ALTRROOT
rpool  68G  10.0G  58.0G  14%  ONLINE  -
```

Use the `-r` option to compare available space with actually used space in the root pool.

```
# zfs list -r rpool
NAME                                USED  AVAIL  REFER  MOUNTPOINT
rpool                                10.2G  56.8G  106K   /rpool
rpool/ROOT                           5.04G  56.8G   31K   legacy
rpool/ROOT/solaris                    5.04G  56.8G  5.04G   /
rpool/dump                             1.00G  56.8G  1.00G   -
rpool/export                           63K    56.8G   32K   /export
rpool/export/home                       31K    56.8G   31K   /export/home
rpool/swap                              4.13G  56.9G  4.00G   -
```

The `zpool list` and `zfs list` commands provide more targeted information than the legacy `df` and `du` commands for determining your available ZFS storage 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 descendent file systems or snapshots.

Displaying the Use of Disk Space on UFS File Systems

To display information about how UFS disk space is used, use the `df` command.

```
$ df
/ (/dev/dsk/c0t0d0s0 ): 101294 blocks 105480 files
/devices (/devices ): 0 blocks 0 files
/system/contract (ctfs ): 0 blocks 2147483578 files
/proc (proc ): 0 blocks 1871 files
/etc/mnttab (mnttab ): 0 blocks 0 files
/etc/svc/volatile (swap ): 992704 blocks 16964 files
/system/object (objfs ): 0 blocks 2147483530 files
```

To find out how disk space is used per user, use the `quot` command.

```
# quot /ufsfs
/dev/rdisk/c3t3d0s0:
21048 root
350 amy
250 rory
```

Note - The `quot` command works only on local legacy UFS file systems.

Displaying Information About File Sizes

To check the size of files and sort them, use the `ls` command. To find files that exceed a size limit, use the `find` command. For more information, see the [ls\(1\)](#) and [find\(1\)](#) man pages.

Using the `ls` Command

The `ls` commands displays a list of files in a specific directory. The following `ls` options are useful for obtaining information about file sizes on the system:

- `-l` – Displays a list of files and directories in long format and shows the sizes in bytes.
- `-h` – Scales file sizes and directory sizes into KB, MB, GB, or TB when the file or directory size is larger than 1024 bytes.
- `-s` – Displays a list of files and directories and shows the sizes in blocks.

For more information, see the [ls\(1\)](#) man page.

The following example shows that the `acct` and `su` log files are the two largest files in the `/var/adm` directory.

```
$ cd /var/adm
$ ls -lh
total 78
-rw----- 1 root  root      36K Nov 26 15:45 acct
-rw----- 1 uucp  bin        0 Nov 26 09:25 aculog
-rw-r--r-- 1 root  root      20K Nov 26 13:55 messages
-rw----- 1 root  root      22K Nov 26 10:30 sulog
```

The following example uses the `-sh` option to indicate the blocks that are used by the files in the first column of the output.

```
$ ls -sh
25 -rw-r--r-- 1 root  root      20K Nov 26 13:55 messages
 7 -rw----- 1 root  root      36K Nov 26 15:45 acct
24 -rw----- 1 root  root      22K Nov 26 10:30 sulog
```

You can combine the `ls` command with the `sort` command to display a directory's files in an ascending or descending order according to a criterion such as file size. For more information, see the [`sort\(1\)`](#) man page.

Using the `find` Command

The `find` command enables you to search for files that fit a specific search criteria. For example, to find files that exceed a specific file size, you would use the following command syntax:

```
$ find directory -size +nnn
```

where *directory* specifies the directory that you want to search and `-size + nnn` provides the desired size in 512-byte blocks.

The following example shows how to find files larger than 400 blocks in the current working directory. The `-print` option displays the output of the `find` command.

```
$ find . -size +400 -print
./Howto/howto.doc
./Howto/howto.doc.backup
./Howto/howtotest.doc
./Routine/routineBackupconcepts.doc
./Routine/routineIntro.doc
```

Displaying Information About Directory Sizes

To display the size of directories and subdirectories, use the `du` command and options. Additionally, you can display the amount of disk space used by user accounts on local UFS file systems by using the `quot` command. For more information, see the [du\(1\)](#) and [quot\(8\)](#) man pages.

The `du` command has the following syntax:

```
$ du [options] [directory1 directory2 ...]
```

The `du` command options are:

- `-a` – Displays the size of each file and subdirectory, and the total number of blocks that are contained in the specified directory.
- `-s` – Displays the total number of blocks that are contained in the specified directory.
- `-H` – Displays the size of each directory in 1000-byte blocks.

The following example shows the size of `/var/adm` and its subdirectories.

```
$ du /var/adm
2    /var/adm/acct/nite
2    /var/adm/acct/sum
8    /var/adm/acct
2    /var/adm/sa
2    /var/adm/sm.bin
258  /var/adm
```

To compare the sizes of different directories, specify those directories in the command. The following example compares the sizes of the `/var/adm` and `/var/spool/lp` directories.

```
$ du /var/adm /var/spool/lp
2    /var/adm/acct/nite
2    /var/adm/acct/sum
8    /var/adm/acct
2    /var/adm/sa
2    /var/adm/sm.bin
258  /var/adm
4    /var/spool/lp/admins
2    /var/spool/lp/requests/printing...
4    /var/spool/lp/requests
4    /var/spool/lp/system
2    /var/spool/lp/fifos
24   /var/spool/lp
```

The following example shows directory sizes in 1024-byte blocks.

```
$ du -h /usr/share/audio
796K /usr/share/audio/samples/au
797K /usr/share/audio/samples
798K /usr/share/audio
```

Maintaining Disks

Perform regular disk maintenance to ensure that efficient use of disk space. To create additional disk space, delete files and directories that you no longer need. This section discusses some disk maintenance tasks.



Caution - Deleting files and directories from the system has permanent results. Unless you have an archive system that backs up your system, deleted files cannot be recovered. Make sure that you remove the correct files and directories.

Removing files from ZFS file system does not free space if they are still referenced in a previous snapshot.

Because file deletion is a critical operation, you must have the appropriate rights to be able to perform system-wide deletions. For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

Removing Old or Inactive Files

Use the `ls -t` command to generate a list of files in a directory and sort them according to their respective time stamps. By default, the files will be listed from the newest files to the oldest. The following example lists the files in `/var/adm` starting from the most recent file.

```
$ ls -t /var/adm
total 134
-rw----- 1 root  root    315 Sep 24 14:00 sulog
-rw-r--r-- 1 root  root  11510 Sep 10 16:13 messages.1
drwxrwxr-x 5 adm   adm    512 Sep 10 15:19 acct
drwxrwxr-x 2 adm   sys    512 Sep 10 15:19 sa
drwxr-xr-x 2 adm   adm    512 Sep 10 15:17 log
```

You can use this information to remove old files that you determine you no longer need.

▼ How to Identify Old or Inactive Files for Deletion

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Send a list of files that have not been accessed for a specified number of days to an output file.

```
# find directory -type f[-atime +nnn] [-mtime +nnn] -print > output-file &
```

directory The directory you want to search, which includes its subdirectories.

-atime +nnn The number of days that files that have not been accessed.

-mtime +nnn The number of days that files have not been modified.

output-file The file to which the output of the command will be written.

3. Ensure that all of the files listed in the output file can be safely removed.

If some files in the list are still needed, delete them from the output file.

4. Remove the files that are listed in the output file.

```
# rm `cat output-file`
```

Example 36 Finding and Removing Old or Inactive Files

This example creates a list of the files in the `/var/share/adm` directory and its subdirectories that have not been accessed in the last 60 days in a file named `/var/tmp/deadfiles`. The `rm` command removes the inactive files listed in the `/var/tmp/deadfiles` file.

```
# find /var/adm -type f -atime +60 -print > /var/tmp/deadfiles &
# more /var/tmp/deadfiles
/var/adm/aculog
/var/adm/spellhist
/var/adm/sa/sa13
/var/adm/sa/sa27
/var/adm/sa/sa11
/var/adm/sa/sa23
/var/adm/sulog
/var/adm/vold.log
/var/adm/messages.1
/var/adm/messages.2
```

```
/var/adm/messages.3  
# rm `cat /var/tmp/deadfiles`  
#
```

Emptying Temporary Directories

The `/var/tmp` and `/var/spool` directories contain temporary files that you don't need to store over long periods of time. You can also create your own directory to contain files that you know are temporary.

To remove unneeded directories or subdirectories, use the `rm -r` command. The following example shows how to empty a user-created temporary directory named `mywork` that also contains temporary subdirectories.

```
# cd mywork  
# ls  
filea.000  
fileb.000  
filec.001  
tempdir/  
drafts/  
# rm -r *  
# ls  
#
```

Removing Dump Files

Dump files contain raw data that is generated when a computer program crashes. You can use this data to diagnose problems with the program. These files are also called "crash dumps," "memory dumps," or "system dumps." Because these files are relevant only in relation to the program's abnormal termination, they have no permanent value. Once you have used the files to diagnose and resolve the problem, you should remove them, especially given that they are typically large files.

System dump files are named `core`. You can delete these files in any of the following ways:

- Remove them from the `/var/crash/system` directory, where `system` identifies the system that generated the dump files. For example:

```
# cd /var/crash/system01  
# rm *
```

- Search a specific directory, often your home directory, and remove any core files.
The following example finds and removes core files in the /home/jones user account directory.

```
# cd /home/jones
# find . -name core -exec rm {} \;
```

About Deferred Dump and System Crash Dumps

The Oracle Solaris deferred dump feature postpones the writing of a crash dump until a system reboots. When a system panic occurs, a core dump file is generated and preserved in memory. When the system comes back online, the core dump is extracted to the file system defined in the dump configuration created through the [dumpadm\(8\)](#) command. Once the dump is written, the system may reboot again to a multiuser configuration. Otherwise, the system proceeds to boot as normal.

Deferred dump takes advantage of Oracle technologies to retain memory across system reboots. The system state during a panic is recorded and preserved in memory for later analysis.

Note - You should always configure a dump device as a backup. After a crash dump, the target file system might not have enough space to store the core dump file. For more information about configuring a backup dump device, see the [dumpadm\(8\)](#) man page.

Deferred dump specifically benefits Oracle systems that have no local disks attached (for example, systems in the M7 series). It also increases overall system availability because the system can return to a running state more quickly after a kernel panic.

For information about saving a crash dump of the Oracle Solaris operating system, see the [savecore\(8\)](#) man page.

Administering the System's Disks

This chapter describes how to administer disks on the system. It covers the following topics:

- “Tools for Managing Disks” on page 115
- “Obtaining Disk Information” on page 116
- “Configuring Disks” on page 124
- “Recovering a Corrupted Disk Label” on page 133
- “Scrubbing a Disk” on page 136
- “Adding a Third-Party Disk” on page 137

For overview information about disk management, see [Chapter 4, “Managing Disks in Oracle Solaris”](#).

Tools for Managing Disks

The Format utility is the central tool for administering disks, enabling you to perform a range of tasks from discovering the types of disks on the system to verifying that these disks are known to the system.

Note - To use the utility, you must have the appropriate administrative rights. Refer to [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

Launch the utility by issuing the `format` command, which displays a list of disks on the system and prompts you to select a disk. After you select the disk, the Format Menu is displayed.

```
FORMAT MENU:
disk      - select a disk
type     - select (define) a disk type
partition - select (define) a partition table
current  - describe the current disk
format   - format and analyze the disk
fdisk    - run the fdisk program ( x86 only)
```

```
repair      - repair a defective sector
label       - write label to the disk
analyze     - surface analysis
defect      - defect list management
backup      - search for backup labels
verify      - read and display labels
save        - save new disk/partition definitions
inquiry     - show vendor, product and revision
volname     - set 8-character volume name
!<cmd>    - execute <cmd>, then return

format>
```

At the `format >` prompt, type the action that you want to perform. Depending on the action that you choose, you are prompted to perform further actions. To exit, you type `quit`.

For more information, see the [format\(8\)](#) man page as well as [Appendix A, “The format command Reference”](#).

The `format -e` command launches the utility that enables you to write EFI-compliant disk labels to support disks with capacities greater than 1 TB. However, because many software components are still limited to 1 TB or less, use this command option with caution. For examples of how to use the `format -e` command, see [“Creating Disk Labels” on page 126](#).

Obtaining Disk Information

To facilitate disk identification, assign aliases to the disks. Use the following command:

```
# fmadm add-alias chassis-name.chassis-serial alias-id
```

You can set a naming standard so that the alias name maps to a specific disk's chassis name and chassis serial number. The following example maps the disk with chassis name SUN-Storage-J4200 and serial number 0905QAJ00E to an alias.

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

For more information about assigning aliases to disks, see the [fmadm\(8\)](#) man page.

Identifying Disks on a System

To identify disks, launch the Format utility by issuing the `format` command. The command displays the disks in the system, as shown in the following example.

```
# format
AVAILABLE DISK SELECTIONS:
0. c2t0d0 <SUN36G cyl 14087 alt 2 hd 24 sec 424>
   /pci@1c,6000000/scsi@2/sd@0,0
   /dev/chassis/J4200@RACK10:U24-25/SCSI_Device__0/disk
1. c2t1d0 <SUN72G cyl 14087 alt 2 hd 24 sec 424>
   /pci@1c,6000000/scsi@2/sd@1,0
   /dev/chassis/J4200@RACK10:U24-25/SCSI_Device__1/disk
Specify disk (enter its number):
```

The command displays a list of recognized disks. In the example's first entry, disk 0 or target 0 is connected to the second SCSI host adapter (`scsi@2`). In turn, the host adapter is connected to the second PCI interface (`/pci@1c,6000000/...`). The output also associates both the physical and logical device name to the disk's marketing name, SUN36G, which is always listed in angle brackets `<>`.

The association enables you to identify which logical device names represent the disks that are connected to your system. For a description of logical and physical device names, see [“Device Naming Conventions” on page 31](#).

For disks that do not have marketing names, use the utility to label the disk and, if necessary, identify its type. See [“Creating Disk Labels” on page 126](#).

You can use a wildcard to display disk information. For example, to display the disks that are connected to controller 0 in the sample output:

```
# format /dev/rdisk/c2t*
```

If the Format utility does not recognize a disk, connect the disk to the system by consulting your disk hardware documentation. The following resources also provide information about how to identify disks:

- [Chapter 7, “Setting Up ZFS on Disks”](#).
- [“How to Label a Disk” on page 126](#).

Displaying Slice or Partition Information

This section provides information about disk slices and partitions and how to display information about them.

The `partition` and `fdisk` options in the Format utility enable you to administer disk partitions or slices. The `fdisk` option is used specifically to manage partitions on x86 based systems, so these partitions are often also called `fdisk` partitions.

Note - Oracle Solaris slices are also called partitions. Certain interfaces might refer to a *slice* as a *partition*. To avoid confusion, this documentation distinguishes between `fdisk` partitions and the entities within the Oracle Solaris `fdisk` partition that might be called slices or partitions.

For easier management, use whole disks for creating ZFS storage non-root pools instead of disk slices. Use a disk slice only if the disk is intended for the ZFS root pool. When you create a pool with whole disks, an EFI label is applied. If you need to prepare a disk for use as a root pool disk, create a slice 0 that contains the entire disk capacity, as shown in [Example 37, “Slice Information on a Disk With a VTOC Label,”](#) on page 119.

For information about setting up disks for use with ZFS storage pools, see [Chapter 7, “Setting Up ZFS on Disks”](#).

Although the exact information that is displayed for a disk or partition varies depending on the label type, it often includes the following data:

Part	Partition or slice number. For VTOC-labeled disks, the partitions range from 0–7. For EFI-labeled disks, the partitions range from 0–6.
Tag	File system that is mounted on the partition.
Flag	Any combination of the following states that apply to a specific partition: writable (w), mountable (m), readable (r), and unmountable (u). <code>wu_rm</code> , for example, is the designation for partitions reserved for swap areas.
Cylinders	Applies only to VTOC-labeled disks and refers to the starting and ending cylinder number for the slice.
Size	Slice or partition size in MB.
Blocks	Applies only to VTOC-labeled disks and refers to the total number of cylinders and the total number of sectors per slice.
First Sector	Applies only to EFI-labeled disks and refers to the starting block number.
Last Sector	Applies only to EFI-labeled disks and refers to the ending block number.

▼ How to Display Partition and Slice Information

1. **Launch the Format utility by typing `format` in a terminal window.**
2. **Select the desired disk from the list of available disks.**

3. At the `format >` prompt, determine whether you are displaying slices or fdisk partitions.

- **x86:** Type `fdisk`.
- **SPARC:**
 - a. Type `partition`.
 - b. Type `print`.

Information about the disk or partition is displayed.

Example 37 Slice Information on a Disk With a VTOC Label

This example assumes that the disk being administered is `c2t3d0`.

```
format> partition
partition> print
Current partition table (c2t3d0):
Total disk cylinders available: 14087 + 2 (reserved cylinders)
```

Part	Tag	Flag	Cylinders	Size	Blocks
0	root	wm	0 - 14086	136.71GB	(14087/0/0) 286698624
1	swap	wu	0	0	(0/0/0) 0
2	backup	wu	0 - 14086	136.71GB	(14087/0/0) 286698624
3	unassigned	wm	0	0	(0/0/0) 0
4	unassigned	wm	0	0	(0/0/0) 0
5	unassigned	wm	0	0	(0/0/0) 0
6	usr	wm	0	0	(0/0/0) 0
7	unassigned	wm	0	0	(0/0/0) 0

```
partition> q
format> q
```

Example 38 Slice Information on a Disk With an EFI Label

This example assumes that the disk being administered is `c2t3d0`.

```
format> partition
partition> print
Current partition table (default):
Total disk sectors available: 286722878 + 16384 (reserved sectors)
```

Part	Tag	Flag	First Sector	Size	Last Sector
0	usr	wm	34	136.72GB	286722911
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
7 reserved  wm      286722912      8.00MB      286739295
partition> q
format> q

```

Example 39 Slice Information on a Disk With an EFI (GPT) Label

This example assumes that the disk being administered is c2t0d0.

```

format> partition
partition> print
Current partition table (original):
Total disk sectors available: 27246525 + 16384 (reserved sectors)
Part   Tag   Flag   First Sector   Size   Last Sector
0  BIOS_boot  wm       256   256.00MB   524543
1     usr    wm   524544   12.74GB   27246558
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
7 reserved   wm   27246559   8.00MB   27262942
partition> q
format> q

```

Example 40 Partition Information From the fdisk Command

The fdisk option of the Format utility shows similar partition information as the partition option but also includes partition types. In the following example, the disk has an EFI and an Oracle Solaris partition, and the Oracle Solaris partition is active.

```

format> fdisk
Part   Tag   Flag   First Sector   Size   Last Sector
0  BIOS_boot  wm       256   256.00MB   524543
1     usr    wm   524544   68.11GB   143358320
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

Total disk size is 8924 cylinders
Cylinder size is 16065 (512 byte) blocks

```

Partition	Status	Type	Cylinders		Length	%
			Start	End		
1		EFI	1	6	6	0
2	Active	Solaris2	7	8925	8919	100

Displaying Disk Label Information

To display disk label information, use the `prtvtoc` command.

```
# prtvtoc path/device-name
```

device-name is the raw disk device in the path that you want to examine.

Note - To use this command, you must have the appropriate administrative rights. Refer to [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

The displayed information varies depending on the current label of the disk. On VTOC-labeled disks, information about tracks and cylinders is included. On EFI-labeled disk, no track or cylinder information is provided.

EXAMPLE 41 Label Information on a Disk With a VTOC Label

```
# prtvtoc /dev/rdisk/c2t3d0s0
* /dev/rdisk/c2t3d0s0 partition map
*
* Dimensions:
*   512 bytes/sector
*   848 sectors/track
*   24 tracks/cylinder
* 20352 sectors/cylinder
* 14089 cylinders
* 14087 accessible cylinders
*
* Flags:
* 1: unmountable
* 10: read-only
*
* Partition Tag Flags First Sector Last Sector Mount Directory
0 2 00 0 286698624 286698623
2 5 01 0 286698624 286698623
```

EXAMPLE 42 Label Information on a Root Pool Disk With an EFI Label

```
# prtvtoc /dev/dsk/c7t0d0s1
* /dev/dsk/c7t0d0s1 partition map
*
* Dimensions:
*   512 bytes/sector
* 156301488 sectors
* 156301421 accessible sectors
*
* Flags:
*   1: unmountable
*  10: read-only
*
* Unallocated space:
*   First Sector Last
*   Sector Count Sector
*     34    222   255
*
*
* Partition Tag Flags First Sector Last Mount Directory
* 0 24 00 256 524288 524543
* 1 4 00 524544 155760527 156285070
* 8 11 00 156285071 16384 156301454
~#
```

EXAMPLE 43 Label Information on a Non-root Pool Disk With an EFI Label

```
# prtvtoc /dev/dsk/c8t3d0
* /dev/dsk/c8t3d0 partition map
*
* Dimensions:
*   512 bytes/sector
* 143374738 sectors
* 143374671 accessible sectors
*
* Flags:
*   1: unmountable
*  10: read-only
*
* Unallocated space:
*   First Sector Last
*   Sector Count Sector
*     34    222   255
*
*
* Partition Tag Flags First Sector Last Mount Directory
```

```
0    4    00          256 143358065 143358320
8    11   00   143358321    16384 143374704
```

Displaying Disk Physical Locations

To display physical locations of disks, use the `croinfo` command, which provides information about the chassis, receptacle, and occupant relative to the specific disk.

```
$ croinfo
D:devchassis-path          t:occupant-type  c:occupant-compdev
-----
/dev/chassis/SYS/HDD0/disk  disk             c2t0d0
/dev/chassis/SYS/HDD1/disk  disk             c2t1d0
/dev/chassis/SYS/HDD2/disk  disk             c2t2d0
```

Use the `croinfo` command options to display information only about a specific disk:

- `croinfo -c disk` displays information only about a specific disk. *disk* refers to the component listed under the `c:occupant-compdev` column.
- `croinfo -c disk -o cp` displays the path that the specific disk occupies when it was installed on the system.

For more information about other options, see the [croinfo\(8\)](#) man page.

Note - The `format` command also provides physical device location information. See the sample output in [“Identifying Disks on a System” on page 116](#).

The following examples show how you can use other commands to identify and locate devices.

EXAMPLE 44 Using the `diskinfo` Command

This example assumes that you assigned the alias `J4200@RACK10:U24-25` to the disk `SUN-Storage-J4200.0905QAJ00E`. For more information about disk aliases, see [“Obtaining Disk Information” on page 116](#).

```
$ diskinfo
D:devchassis-path          c:occupant-compdev
-----
/dev/chassis/J4200@RACK10:U24-25/SCSI_Device__0/disk  c2t0d0
/dev/chassis/J4200@RACK10:U24-25/SCSI_Device__1/disk  c2t1d0
/dev/chassis/J4200@RACK10:U24-25/SCSI_Device__2/disk  c2t2d0
```

EXAMPLE 45 Using the `prtconf` Command

This example shows how to use the `prtconf` command to display disk information.

```
$ prtconf -l | more
System Configuration: Oracle Corporation sun4v
Memory size: 523776 Megabytes
System Peripherals (Software Nodes):

ORCL,SPARC-T3-4 location: /dev/chassis//SYS/MB/HDD0/disk
scsi_vhci, instance #0 location: /dev/chassis//SYS/MB/HDD0/disk
disk, instance #4 location: /dev/chassis//SYS/MB/HDD4/disk
disk, instance #5 location: /dev/chassis//SYS/MB/HDD5/disk
disk, instance #6 location: /dev/chassis//SYS/MB/HDD6/disk
```

EXAMPLE 46 Using the `zpool` Command

This example shows how to use the `zpool` command to display disk information.

```
% zpool status -l export
pool: export
state: ONLINE
scan: none requested
config:

NAME                                STATE      READ WRITE CKSUM
export                               ONLINE    0    0    0
mirror-0                             ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD0/disk       ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD1/disk       ONLINE    0    0    0
mirror-1                             ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD2/disk       ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD3/disk       ONLINE    0    0    0
mirror-2                             ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD4/disk       ONLINE    0    0    0
/dev/chassis//SYS/MB/HDD5/disk       ONLINE    0    0    0

errors: No known data errors
```

Configuring Disks

This section describes disk configuration tasks such as formatting, labeling, or partitioning disks. Disks are typically formatted and configured by the manufacturers and these default configurations are generally sufficient. However, you might need to perform some disk configuration in circumstances such as disk corruption and recovery.



Caution - Formatting a disk destroys existing data on the disk, and relabeling removes existing partition information. Make sure to perform the necessary backups to ensure that no data loss occurs if you reconfigure a disk.

The procedures to configure disks on both SPARC based and x86 based systems are similar. However, with x86 based systems, you use the `fdisk` option of the Format utility for disk operations.

To configure a disk, the disk must be inactive. Thus, if the disk to be configured contains Oracle Solaris, then you must boot from a different media. For more information about booting Oracle Solaris systems, see the topics on booting from a local media or from the network in [Booting and Shutting Down Oracle Solaris 11.4 Systems](#).

Formatting a Disk

An unformatted disk is unusable. The Format utility can detect only formatted disks. Select the disk that you want to verify, as shown in the following example for the `c2t1d0` disk. After you select the disk, the utility indicates whether the disk is formatted.

```
# format
AVAILABLE DISK SELECTIONS:
0. c2t0d0 <SUN36G cyl 14087 alt 2 hd 24 sec 424>
   /pci@1c,600000/scsi@2/sd@0,0
   /dev/chassis/J4200@RACK10:U24-25/SCSI_Device__0/disk
1. c2t1d0 <SUN72G cyl 14087 alt 2 hd 24 sec 424>
   /pci@1c,600000/scsi@2/sd@1,0
   /dev/chassis/J4200@RACK10:U24-25/SCSI_Device__1/disk
Specify disk (enter its number): 1    Disk c2t1d0 is selected.
selectin c2t1d0
[disk formatted]    The selected disk is already formatted.
```

The Format utility automatically configures any unlabeled SCSI disk. The utility would display information about the formatted disk as follows:

```
c2t3d0: configured with capacity of 136.73GB
```

Note - Because formatting disks destroys data, if you suspect that a disk is corrupted, select `analyze` from the Format menu to perform a surface analysis of the disk. After seeing the results of the test, you can determine whether formatting is necessary.

EXAMPLE 47 Formatting Disk c2t1d0

This example shows how to format the c2t1d0 disk that you selected after launching the Format utility.

```
format> format    Formatting is selected.
The protection information is not enabled
The disk will be formatted with protection type 0

Ready to format. Formatting cannot be interrupted
and takes 169 minutes (estimated). Continue? yes

Beginning format. The current time is Fri Apr 1 ...

Formatting...
done

Verifying media...
pass 0 - pattern = 0xc6dec6de
14086/23/734

pass 1 - pattern = 0x6db6db6d
14086/23/734

Total of 0 defective blocks repaired.

format> q
```

Creating Disk Labels

You create a disk label under the following circumstances:

- During a system installation
- When adding new disks
- If the disk label becomes corrupted
- If you change the disk type

▼ How to Label a Disk

1. **Launch the Format utility in Oracle Solaris.**

```
# format
```

Note - To apply an EFI label, use the `format -e` command syntax instead. See [Example 49, “Labeling a Disk With an EFI Label,”](#) on page 128.

A numbered list of disks is displayed.

2. **When prompted, type the number of the disk that you want to label.**
3. **If the utility does not recognize the disk type or if you want to change the disk type, specify the disk type.**
 - a. **At the `format >` prompt, choose `type`.**
 - b. **Type the number that corresponds to the disk's type.**

If your disk is a SCSI-2 disk, you can choose to autoconfigure the disk by typing zero (0).
4. **Label the disk.**

Perform one of the following actions depending on which prompt is displayed.

 - **At the `format >` prompt, type `label`, then proceed as prompted.**
 - **At the confirmation prompt, type `y`.**
5. **(Optional) Verify the results of the labeling process by typing `verify` at the `format >` prompt.**
6. **Exit the Format utility by typing `quit` at the `format >` prompt.**

Example 48 Labeling a Disk

This example shows how to automatically configure a new and unlabeled disk, `c2t1d0`.

```
# format
...
Specify disk (enter its number): 1
c2t1d0: configured with capacity of 33.92GB
Disk not labeled. Label it now? yes
format> verify
    Information is displayed.
format> q
```

Example 49 Labeling a Disk With an EFI Label

This example shows how to use the `format -e` command to label a disk with an EFI label. Make sure to verify that your layered software products will continue to work on systems with EFI-labeled disks. For more information about EFI label features, see [“About EFI \(GPT\) Disk Labels” on page 100](#).

This example assumes that the selected disk to label is `c2t3d0`.

```
# format -e
...
format> label
[0] SMI Label
[1] EFI Label
Specify Label type[0]: 1
Ready to label disk, continue? yes
format> quit
```

Example 50 Labeling a Disk With an SMI Label

This example applies an SMI label to `c2t0d0`. Because the disk previously had an EFI label, the example includes a warning. Otherwise, the labeling would proceed without any further warnings.

```
# format -e
...
Specify disk (enter its number): 3
selecting c2t0d0
[disk formatted]
...
format> label
[0] SMI Label
[1] EFI Label
Specify Label type[1]: 0
Warning: This disk has an EFI label. Changing to SMI label will erase all
current partitions.
Continue? yes
Auto configuration via format.dat[no]?
Auto configuration via generic SCSI-2[no]?
```

Modifying Slices or Partitions

In most cases, disks are formatted and partitioned by the manufacturer. You need to configure disk partitions or slices only if you want to modify the partition configuration by changing the slice or partition size or the partition type.

SPARC: Using the partition Option

The Format utility's partition option configures disk slices on SPARC based systems. The example in this section illustrates the use of the partition option.

EXAMPLE 51 SPARC: Resizing a Disk Slice

In this example, the root pool disk's size is insufficient. For an optimal size, the bulk of the disk space must be in slice 0. You change the partition size by modifying the current partition.

```
... Format Menu
format> partition
partition> print
Current partition table (default):
Total disk cylinders available: 14085 + 2 (reserved cylinders)

Part    Tag    Flag    Cylinders    Size    Blocks
0      root    wm      1 - 13      129.19MB (13/0/0) 264576
1      swap    wu      14 - 26      129.19MB (13/0/0) 264576
2      backup  wu      0 - 14086    136.71GB (14087/0/0) 286698624
3  unassigned  wm      0            0      (0/0/0) 0
4  unassigned  wm      0            0      (0/0/0) 0
5  unassigned  wm      0            0      (0/0/0) 0
6      usr    wm      27 - 14084    136.43GB (14058/0/0) 286108416
7  unassigned  wm      0            0      (0/0/0) 0
8      boot    wu      0 - 0        9.94MB (1/0/0) 20352
9  alternates  wm      0            0      (0/0/0) 0

partition> modify Change partition size.
Select partitioning base:
0. Current partition table (default)
1. All Free Hog
Choose base (enter number) [0]? 1

Part    Tag    Flag    Cylinders    Size    Blocks
0      root    wm      0            0      (0/0/0) 0
1      swap    wu      0            0      (0/0/0) 0
2      backup  wu      0 - 14084    136.69GB (14085/0/0) 286657920
3  unassigned  wm      0            0      (0/0/0) 0
4  unassigned  wm      0            0      (0/0/0) 0
5  unassigned  wm      0            0      (0/0/0) 0
6      usr    wm      0            0      (0/0/0) 0
7  unassigned  wm      0            0      (0/0/0) 0
8      boot    wu      0 - 0        9.94MB (1/0/0) 20352
9  alternates  wm      0            0      (0/0/0) 0

Do you wish to continue creating a new partition
```

```
table based on above table[yes]? yes
Free Hog partition[6]? 0
Enter size of partition '1' [0b, 0c, 0.00mb, 0.00gb]:
Enter size of partition '3' [0b, 0c, 0.00mb, 0.00gb]:
Enter size of partition '4' [0b, 0c, 0.00mb, 0.00gb]:
Enter size of partition '5' [0b, 0c, 0.00mb, 0.00gb]:
Enter size of partition '6' [0b, 0c, 0.00mb, 0.00gb]:
Enter size of partition '7' [0b, 0c, 0.00mb, 0.00gb]:

Part    Tag    Flag    Cylinders    Size    Blocks
0      root   wm      1 - 14084    136.68GB (14084/0/0) 286637568
1      swap   wu      0            0      (0/0/0) 0
2      backup wu      0 - 14084    136.69GB (14085/0/0) 286657920
3 unassigned wm      0            0      (0/0/0) 0
4 unassigned wm      0            0      (0/0/0) 0
5 unassigned wm      0            0      (0/0/0) 0
6      usr    wm      0            0      (0/0/0) 0
7 unassigned wm      0            0      (0/0/0) 0
8      boot   wu      0 - 0        9.94MB (1/0/0) 20352
9 alternates wm      0            0      (0/0/0) 0

Okay to make this the current partition table[yes]? yes
Enter table name (remember quotes): "c2t0d0"
Ready to label disk, continue? yes
partition> q
format> q
```

x86: Using the fdisk Option

You use the `fdisk` option of the `Format` utility to administer `fdisk` partitions on x86 based systems.

You can use x86 type disks for ZFS storage pools provided that the following requirements are met:

- If the disk has multiple partitions, one of partitions must be an Oracle Solaris partition.
With the `fdisk` option, you can determine whether an Oracle Solaris partition exists. If not, create one, as shown in [Example 52, “Creating an Oracle Solaris fdisk Partition That Spans the Entire Drive,”](#) on page 131.
- The Oracle Solaris partition must be the active partition on the disk.
The active partition is the partition whose operating system will be booted by default at system startup.
- Oracle Solaris `fdisk` partitions must begin on cylinder boundaries.

The Oracle Solaris `fdisk` partitions must not begin at cylinder 0 on the first disk, which is reserved for storing additional boot information, including the master boot record.

- The Oracle Solaris `fdisk` partition can be the entire disk or only part of the disk to leave space for other partitions.

Provided that the disk has sufficient space, you can create new partitions without having to reconfigure existing partitions on the disk.

All `fdisk` partitions have identifiers. An Oracle Solaris partition has two identifiers:

- Solaris uses the `0x82` identifier.
- Solaris2 uses the `0xbf` identifier.

All Oracle Solaris commands, utilities, and drivers have been updated to work with either identifier with no affect on the `fdisk` functionality. Therefore, you can switch between the two identifiers by selecting the appropriate option from the `fdisk` menu as follows:

```
format > fdisk
...
SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs      Toggle between identifiers
5. Edit/View extended partitions
6. Exit (update disk configuration and exit)
7. Cancel (exit without updating disk configuration)
```

Note - You can change the `fdisk` identifier even when the file system that is contained in the partition is mounted.

EXAMPLE 52 x86: Creating an Oracle Solaris `fdisk` Partition That Spans the Entire Drive

The following example shows how to create an Oracle Solaris `fdisk` partition that spans the entire `c8t3d0` drive.

```
# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
0. c8t0d0 <SEAGATE-ST973401LSUN72G-0556 cyl 8921 alt 2 hd 255 sec 63>
   /pci@0,0/pci1022,7458@11/pci1000,3060@4/sd@0,0
   /dev/chassis/SYS/HD0/disk
1. c8t1d0 <SEAGATE-ST973401LSUN72G-0556 cyl 8921 alt 2 hd 255 sec 63>
   /pci@0,0/pci1022,7458@11/pci1000,3060@4/sd@1,0
   /dev/chassis/SYS/HD1/disk
```

```

2. c8t2d0 <SEAGATE-ST973401LSUN72G-0556-68.37GB>
   /pci@0,0/pci1022,7458@11/pci1000,3060@4/sd@2,0
   /dev/chassis/SYS/HD2/disk
3. c8t3d0 <SEAGATE-ST973401LSUN72G-0556 cyl 14087 alt 2 hd 24 sec 424>
   /pci@0,0/pci1022,7458@11/pci1000,3060@4/sd@3,0
   /dev/chassis/SYS/HD3/disk
Specify disk (enter its number): 3
selecting c8t3d0
[disk formatted]
No Solaris fdisk partition found.
format> fdisk
No fdisk table exists. The default partitioning for your disk is:

a 100% "SOLARIS System" partition.

Type "y" to accept the default partition, otherwise type "n" to edit the
partition table. y

format> label
Ready to label disk, continue? yes
format> quit

```

EXAMPLE 53 x86: Converting an x86 Partition to an Oracle Solaris Partition

This example shows how to convert an existing partition to an Oracle Solaris partition. By default, disks have the EFI label on most x86 based systems. To change a partition type, you must first destroy the existing one. When you change partition types, the labels also change automatically. Because the disk is originally an EFI disk, use the `format -e` command to launch the Format utility.

```

# format -e
...
format> fdisk
FORMAT MENU:
disk      - select a disk
type      - select (define) a disk type
Total disk size is 17833 cylinders
Cylinder size is 16065 (512 byte) blocks

Cylinders
Partition  Status   Type           Start  End    Length  %
=====  =====  =====
1          EFI         0         17833  17834   100

SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition

```

```

3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Edit/View extended partitions
6. Exit (update disk configuration and exit)
7. Cancel (exit without updating disk configuration)
Enter Selection: 3
Specify the partition number to delete (or enter 0 to exit): 1
This will make all files and
programs in this partition inaccessible (type "y" or "n"). y
Enter Selection: 1
Select the partition type to create:
1=SOLARIS2  2=UNIX      3=PCIXOS    4=Other      5=DOS12
6=DOS16    7=DOSEXT    8=DOSBIG   9=DOS16LBA  A=x86 Boot
B=Diagnostic C=FAT32    D=FAT32LBA E=DOSEXTLBA F=EFI (Protective)
G=EFI_SYS  0=Exit? 1
Specify the percentage of disk to use for this partition
(or type "c" to specify the size in cylinders). 100
Should this become the active partition? If yes, it will be activated
each time the computer is reset or turned on.
Please type "y" or "n". y
Enter Selection: 6
Partition 1 is now the active partition.

```

Recovering a Corrupted Disk Label

A power or system failure might cause a disk's label to become unrecognizable. Although a corrupted disk label does not always mean that the slice information or the disk's data must be re-created or restored, the label itself must be restored.

Recovering a corrupted disk label requires two general steps: specifying the correct type for the disk and then recovering the backup label.

▼ How to Recover a Corrupted Disk Label

1. Boot the system to single-user mode.

Use either a local Oracle Solaris DVD or the network to boot and access the disk.

For information about booting the system, see [Booting and Shutting Down Oracle Solaris 11.4 Systems](#).

2. Launch the Format utility.

format

3. Type the number of the disk that you need to recover.

Specify disk (enter its number):

If the utility can configure the selected disk, the utility displays the following message:

disk: configured with capacity of *size*

4. Determine how to label the disk.

■ **If the disk was configured successfully:**

a. At the `format >` prompt, type `verify`.

The verification process includes searching for the disk's backup label.

b. Ensure that the contents of the retrieved backup label appear satisfactory.

c. At the `format >` prompt, type `backup` to apply the label.

d. When prompted, confirm the command.

■ **If the disk was *not* configured successfully:**

a. At the `format >` prompt of the Format menu, type `type`.

The Available Drives Type menu is displayed.

b. Type the number that corresponds to the disk's type.

c. When prompted to proceed with labeling the disk, type `no`.

d. At the `format >` prompt, type `verify`.

The verification process includes searching for the disk's backup label.

e. Ensure that the contents of the retrieved backup label appear satisfactory.

f. At the `format >` prompt, type `backup` to apply the label.

g. When prompted, confirm the command.

5. After the label is restored, exit the Format utility by typing `q` or `quit`.

6. Verify the file systems on the recovered disk.

For information about using the `zpool scrub` command for ZFS file systems, see the [zpool\(8\)](#) man page.

Example 54 Recovering the Label of an Autoconfigured Disk

This example assumes that you have already selected the disk whose label you want to recover.

```
format> verify
Warning: Could not read primary label.
Warning: Check the current partitioning and 'label' the disk or
use the 'backup' command.
Backup label contents:
Volume name = <          >
ascii name = <FUJITSU-MAP3147N SUN146G-0501>
pcyl      = 14089
ncyl      = 14087
acyl      = 2
nhead     = 24
nsect     = 848
Part      Tag   Flag   Cylinders      Size      Blocks
0         root   wm     0 - 14086      136.71GB  (14087/0/0) 286698624
1         swap   wu     0              0         (0/0/0)    0
2         backup wu     0 - 14086      136.71GB  (14087/0/0) 286698624
3         unassigned wm     0              0         (0/0/0)    0
4         unassigned wm     0              0         (0/0/0)    0
5         unassigned wm     0              0         (0/0/0)    0
6         usr    wm     0              0         (0/0/0)    0
7         unassigned wm     0              0         (0/0/0)    0
```

After the backup label is retrieved and you ensure that the contents are satisfactory, proceed with applying the label.

```
format> backup
Disk has a primary label, still continue? y

Searching for backup labels...found.
Restoring primary label

format> q
```

Example 55 Recovering the Label of a Disk Not Automatically Configurable

This example assumes that you have already selected the disk whose label you want to recover.

```
format> type
Specify disk type (enter its number)[12]: 12
Disk not labeled. Label it now? no

format> verify
Warning: Could not read primary label.
Warning: Check the current partitioning and 'label' the disk
or use the 'backup' command.
Backup label contents:
Volume name = < >
ascii name = <FUJITSU-MAP3147N SUN146G-0501>
pcyl      = 14089
ncyl      = 14087
acyl      = 2
nhead     = 24
nsect     = 848
Part      Tag   Flag   Cylinders      Size      Blocks
0        root   wm     0 - 14086     136.71GB  (14087/0/0) 286698624
1        swap   wu      0              0          (0/0/0)      0
2        backup wu     0 - 14086     136.71GB  (14087/0/0) 286698624
3 unassigned wm      0              0          (0/0/0)      0
4 unassigned wm      0              0          (0/0/0)      0
5 unassigned wm      0              0          (0/0/0)      0
6        usr   wm      0              0          (0/0/0)      0
7 unassigned wm      0              0          (0/0/0)      0
```

After the backup label is retrieved and you ensure that the contents are satisfactory, proceed with applying the label.

```
format> backup
Disk has a primary label, still continue? y
Searching for backup labels...found.
Restoring primary label

format> q
```

Scrubbing a Disk

You can use the `sg_sanitize` command to remove or scrub all the data from a disk. To invoke the `sg_sanitize` command, you must first install the `pkg:/system/storage/sg3_utils` package. The purpose of the sanitize operation is to alter the information in the cache and on the

medium of a logical unit (for example, a disk) so that the recovery of the data is not possible. You can also scrub solid state drives (SSDs) using the `sg_sanitize` command.

Once the `sg_sanitize` command is started on a disk, then the data in that disk is no longer available. Even if the disk is power cycled, the sanitize operation will continue after power is re-instated until the operation is complete. For more information, see the [sg_sanitize\(8\)](#) man page.

Adding a Third-Party Disk

Oracle Solaris supports many third-party disks. However, for the disk to be recognized, you might need to supply a device driver.

Other options for adding disks are as follows:

- If you are adding a SCSI disk, try the Format utility's automatic configuration feature.
- If you are adding a PCI, SCSI, or USB disk, try hot-plugging the disk. For more information, see [Chapter 1, “Managing Devices in Oracle Solaris”](#).

Note - The Format utility will not necessarily work properly with all third-party disk drivers. If the disk driver is not compatible with the Format utility, the disk drive vendor should supply you with a custom disk formatting program.

If you invoke the Format utility and find that the disk type is not recognized, the Format utility probably does not support the disk type.

Refer to the appropriate configuration procedure for adding system disks or secondary disks in [Chapter 7, “Setting Up ZFS on Disks”](#).

Setting Up ZFS on Disks

This chapter describes how to set up disks for ZFS file systems on both SPARC based and x86 based systems. It covers the following topics:

- “About ZFS Disk Setup on Oracle Solaris Systems” on page 139
- “Setting Up Disks for ZFS File Systems” on page 141
- “Configuring a Disk for a ZFS Non-Root File System” on page 145

For overview information about disk management, see [Chapter 4, “Managing Disks in Oracle Solaris”](#).

About ZFS Disk Setup on Oracle Solaris Systems

You can set up a ZFS file system on any disk. However, a ZFS file system is not directly mapped to a disk or a disk slice. You must create a ZFS storage pool before creating a ZFS file system. For more information about ZFS storage pools, see [Chapter 5, “Managing Oracle Solaris ZFS Storage Pools”](#) in *Managing ZFS File Systems in Oracle Solaris 11.4*.

Note - You must properly configure your system disks before you can set up storage pools. For information about disk configuration, see [“Configuring Disks” on page 124](#).

A root pool contains the root file system that is used to boot Oracle Solaris. A disk that is used in a non-root pool usually contains user or data files. You can attach additional disks to a root pool or a non-root pool for increased disk space.

To reduce system down time due to hardware failures, create a redundant root pool so that if a root pool disk becomes damaged, the system can still boot. For redundant root pool configurations, Oracle Solaris supports only a mirrored root pool. In a mirrored root pool, you can add, replace, or detach disks to manage a pool's size.

You can recover from a damaged root pool disk either by reinstalling the entire Oracle Solaris OS or by replacing the root pool disk and restoring your file systems from snapshots or from a backup medium.

You can replace a disk in a redundant pool provided that enough redundancy exists among the other devices. In a non-redundant pool, you can replace a disk only if all of the devices are in the ONLINE state.

Preparing a Disk for a ZFS Root File System

The root pool disk requirements for SPARC based and x86 based systems are as follows:

- The disk must either be a single disk or part of a mirrored configuration. Non-redundant configurations and RAIDZ configurations are not supported for the root pool.
- All subdirectories of the root file system except /var that are part of the OS image must be in the same dataset as the root file system.
- All Oracle Solaris components except the swap and dump devices must reside in the root pool.
- For a root pool disk that is VTOC labeled, you must create a disk slice with the bulk of disk space in slice 0 if you need to replace a root pool disk.

For a pool to be efficient, do not use different slices on a disk to share among different operating systems or with a different ZFS storage pool or storage pool components.

Oracle Solaris installs an EFI (GPT) label for the root pool disk or disks on most x86 based systems and on SPARC based systems with updated GPT firmware. However, the SMI (VTOC) label is still available and supported.

If your SPARC based system's firmware is not updated for GPT support, you must create a disk slice for a disk that is intended for a ZFS root pool. However, on x86 based systems with a root pool disk that is labeled with EFI, the correct boot partitions are created automatically.

Adding or Replacing Disks for ZFS File Systems

This section describes general steps to change disks. Consult your hardware documentation for the specific correct method for your setup. For information about dynamic reconfiguration (DR), including procedures and examples of DR operations, read [Chapter 2, “Dynamically Configuring Devices”](#).

▼ How to Add Disks

1. **Become an administrator.**
2. **If required, bring the failed disk offline.**

```
# zpool offline root-pool disk
```

3. **If required, unconfigure the disk.**

```
# cfgadm -c unconfigure disk-apid
```

In this command, *disk-apid* refers to the device's logical attachment point ID. For more information about these IDs, see [“About Attachment Point Identification” on page 37](#). See also [“Configuring or Unconfiguring a SCSI Device” on page 40](#) for additional information about unconfiguring and configuring disks.

The following example unconfigures the disk `c2t1d0`.

```
# cfgadm -c unconfigure c2::dsk/c2t1d0
```

4. **Install the new disk.**
5. **If required, configure the new disk.**

```
# cfgadm -c configure disk-apid
```

Setting Up Disks for ZFS File Systems

This section describes how to set up ZFS storage pools after you have completed configuring your system's disks.

To perform any of these procedures, you must boot from a separate Oracle Solaris installation DVD that is either accessed locally or from the network. For instructions, see the topics on booting from a local media or from the network in [Booting and Shutting Down Oracle Solaris 11.4 Systems](#).

▼ How to Re-Create the ZFS Root Pool (EFI (GPT))

This procedure describes how to re-create the ZFS root pool or create an alternate root pool.

Before You Begin If you are performing this procedure on an x86 system, ensure that the disk has a Oracle Solaris partition that is also selected as the active partition. Use the `fdisk` option of the Format utility to view partition information. [Example 40, “Partition Information From the `fdisk` Command,” on page 120](#) partially shows the information that the option displays.

If no Oracle Solaris partition exists, You must create one. For more information about how to create an `fdisk` partition, see [Example 52, “Creating an Oracle Solaris `fdisk` Partition That Spans the Entire Drive,” on page 131](#).

1. **Become an administrator.**
2. **Identify the disks for the root pool by issuing the `format` command to launch the Format utility.**

The following example shows sample output on a SPARC system.

```
# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
  0. c3t0d0 <FUJITSU-MAV2073RCSUN72G-0301 cyl 14087 alt 2 hd 24 sec 424>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@0,0
  1. c3t1d0 <FUJITSU-MAV2073RCSUN72G-0301 cyl 14087 alt 2 hd 24 sec 424>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@1,0
  2. c3t2d0 <FUJITSU-MAV2073RCSUN72G-0301-68.37GB>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@2,0
  3. c3t3d0 <FUJITSU-MAV2073RCSUN72G-0301-68.37GB>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@3,0
```

The following example shows sample output on an x86 system.

```
# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
  0. c6t0d0 <SUN72G cyl 14087 alt 2 hd 24 sec 424>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@0,0
  1. c6t1d0 <FUJITSU-MAV2073RCSUN72G-0301-68.37GB>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@1,0
  2. c6t2d0 <FUJITSU-MAV2073RCSUN72G-0301-68.37GB>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@2,0
  3. c6t3d0 <FUJITSU-MAV2073RCSUN72G-0301 cyl 14087 alt 2 hd 24 sec 424>
    /pci@7c0/pci@0/pci@1/pci@0,2/LSILogic,sas@2/sd@3,0
Specify disk (enter its number):
```

3. **Type `quit` to exit the Format utility.**
4. **Re-create the root pool.**

```
# zpool create -B root-pool mirror disk1 disk2
```

This command automatically creates an EFI (GPT) labeled disk with the correct boot information.

The following example sets and mirrors `rpool` on `c3t0d0` and `c3t1d0`.

```
# zpool create -B rpool mirror c3t0d0 c3t1d0
```

5. (Optional) Restore the root pool snapshots.

For information about complete ZFS root pool recovery, see [Using Unified Archives for System Recovery and Cloning in Oracle Solaris 11.4](#).

▼ How to Replace a ZFS Root Pool Disk

The root pool disk is installed automatically when the system is installed. Use this procedure if you need to replace a root pool disk or attach a new disk as a mirrored root pool disk.

Before You Begin Before you perform this procedure, ensure that you have completed the following tasks:

- Installed the new or replacement disk. See [“Adding or Replacing Disks for ZFS File Systems”](#).
- If you are replacing a disk with a VTOC label, ensure that you have verified that the disk has a VTOC label.

Use the `prtvtoc path/disk-name` command to verify. See [“Displaying Disk Label Information” on page 121](#) for other commands you can use. If you need to change the label from EFI to VTOC, see [“Creating Disk Labels” on page 126](#) for instructions with an example in [Example 50, “Labeling a Disk With an SMI Label,” on page 128](#).

- Verified the slice or partition information.
 - SPARC: Verify that slice 0 uses most of the disk's size for optimal configuration. Use the Format utility to verify. If you need to change the slice configuration, see [“Modifying Slices or Partitions” on page 128](#) with an example in [Example 51, “Resizing a Disk Slice,” on page 129](#).
 - x86: Ensure that the disk has an Oracle Solaris partition that is also selected as the active partition.

Use the `fdisk` option of the Format utility to view partition information. [Example 40, “Partition Information From the fdisk Command,” on page 120](#) partially shows the information that the option displays.

If no Oracle Solaris partition exists, create one. See [Example 52, “Creating an Oracle Solaris fdisk Partition That Spans the Entire Drive,” on page 131](#) as a guide.

1. **Become an administrator.**
2. **Replace the root pool on the new disk.**

```
# zpool replace root-pool disk
```

3. **Replace the failed disk or attach a new disk.**

- **To replace a failed disk with a new disk:**

- a. **If the new disk is not online, bring it online.**

```
# zpool online root-pool disk
```

- b. **Verify that the new disk is resilvered.**

```
# zpool status root-pool
```

- c. **(Optional) Install Oracle Solaris and then boot the system.**

- d. **Apply the boot blocks after the new disk is resilvered.**

```
# bootadm install-bootloader
```

For more information about booting Oracle Solaris systems, see [Booting and Shutting Down Oracle Solaris 11.4 Systems](#).

- e. **Verify that the boot blocks are installed by rebooting the system to run level 3.**

```
# init 6
```

- **To attach a new disk to create a mirrored root pool or attach a larger disk to replace a smaller disk:**

- a. **Attach the new disk to the ZFS pool.**

```
# zpool attach root-pool disk new-disk
```

The following example attaches the new disk `c2t1d0s0` to the current `rpool` on `c2t0d0s0`.

```
# zpool attach rpool c2t0d0s0 c2t1d0s0
```

The `zpool attach` command also automatically applies the boot blocks.

- b. **Verify that you can boot from the new disk.**
- c. **If you are replacing an old disk with a new disk, detach the old disk after the system boots from the new disk.**

```
# zpool detach root-pool old-disk
```

For example, if you are replacing `c2t0d0s0` with `c2t1d0s0`, you would type the following command:

```
# zpool detach rpool c2t0d0s0
```

4. **Set up the system to boot automatically from the new disk.**
 - **SPARC:** Either use the `eeeprom` command or the `setenv` command from the SPARC boot PROM.
 - **x86:** Reconfigure the system's BIOS.

Configuring a Disk for a ZFS Non-Root File System

A disk that is set up for a non-root ZFS file system is relabeled automatically when the pool is created or when the disk is added to the pool. If you use a whole disk either to create a pool or to add to a ZFS storage pool, an EFI label is applied.

Most modern bus types support hot-plugging, which enables a system to immediately recognize a disk that you insert into an empty slot. For more information about hot-plugging devices, see [Chapter 2, “Dynamically Configuring Devices”](#).

▼ How to Set Up a Disk for a ZFS Non-Root File System

This procedure assumes that you have installed the replacement disk on the system.

For information about adding disks, see [“Adding or Replacing Disks for ZFS File Systems” on page 140](#).

1. **Become an administrator.**

2. **Launch the Format utility to verify that the new disk is listed in the output and therefore accessible.**

```
# format
```

3. **Type `quit` to exit the Format utility.**

4. **Replace the root pool on the new disk.**

```
# zpool replace non-root disk
```

5. **If required, bring the new disk online.**

```
# zpool online non-root disk
```

6. **Verify that the new disk is resilvered.**

```
# zpool status non-root
```

7. **Attach the new disk to the ZFS pool.**

```
# zpool attach root-pool old-disk new-disk
```

Example 56 Setting Up a Disk for a ZFS Non Root Pool

In this example, the new disk `c1t1d0` is installed for the ZFS non root pool tank.

```
# zpool replace tank c1t1d0
# zpool online tank c1t1d0
# zpool status tank
# zpool attach tank mirror c1t1d0 c2t0d0
```

Configuring Storage Devices With COMSTAR

This chapter describes how to configure Common Multiprotocol SCSI TARget, or COMSTAR, a software framework that enables you to convert any Oracle Solaris 11.4 system into a SCSI target device that can be accessed over a storage network by initiator hosts. The advantage of setting up Oracle Solaris iSCSI targets is that you can use the existing FC devices to connect to other clients without additional FC-HBAs. In addition, systems with dedicated arrays can now share replicated storage with ZFS or UFS file systems.

This means you can make storage devices on a system available to Linux, Mac OS, or Windows client systems as if they were local storage devices. Supported storage protocols are iSCSI, FC, iSER, and SRP.

For information about configuring iSCSI initiators, see [Chapter 5, “Configuring an Oracle Solaris iSCSI Initiator”](#) in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*.

For information about the iSNS support in Oracle Solaris, see [Chapter 9, “Configuring and Managing the Oracle Solaris Internet Storage Name Service \(iSNS\)”](#).

For troubleshooting general iSCSI configuration problems in Oracle Solaris, see [“Troubleshooting iSCSI Configuration Problems”](#) in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*.

Overview of COMSTAR Features

COMSTAR uses a SCSI Target Mode Framework (STMF) to manage target storage devices with the following components:

- Port providers (or plug-ins) – Implement protocols, such as Fibre Channel (FC) and iSCSI.
- Logical unit providers – Emulate various SCSI devices, such as disk and tape devices.
- The libstmf management library – Provides the COMSTAR management interface. The modules that implement the iSCSI functionality do not interact directly with the underlying transport. In a similar way, the modules that implement the transport protocol are unaware

of the SCSI-level functionality that is inherent in the packets they are transporting. Some transport examples are Fibre Channel and iSCSI. The framework separates the execution and cleanup of SCSI commands and the associated resources. This separation simplifies the task of writing SCSI or transport modules.

Use the following to administer these features:

- The `itadm` command manages Internet SCSI (iSCSI) nodes within the SCSI target mode framework.
- The `stmfadm` command configures logical units within the SCSI target mode framework.
- The `srptadm` command manages SCSI RDMA Protocol (SRP) target ports within the SCSI target mode framework.

To use COMSTAR features, the following components must be installed on your system:

- Oracle Solaris storage software and devices
- The `group/feature/storage-server` software package for the system that provides the storage devices
- Any supported NIC

Configuring Storage Devices With COMSTAR Task Map

This is a general list of tasks associated with configuring storage devices with COMSTAR. Some of the tasks are optional depending on your network configuration needs. Some of the links below will take you to separate documents that describe network configuration and initiator configuration.

- [Administering TCP/IP Networks, IPMP, and IP Tunnels in Oracle Solaris 11.4](#)
- [“Configuring Storage Devices With COMSTAR” on page 150](#)
- [“Configuring Dynamic or Static Target Discovery” on page 149](#)
- [Chapter 5, “Configuring an Oracle Solaris iSCSI Initiator” in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*](#)
- [“How to Access iSCSI Disks” on page 160](#)
- [“Configuring Authentication in an iSCSI-Based Storage Network” in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*](#)
- [Chapter 5, “Configuring an Oracle Solaris iSCSI Initiator” in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*](#)
- [“Displaying iSCSI Configuration” in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*](#)

COMSTAR Terminology

Review the following terminology before configuring target devices with COMSTAR.

Term	Description
Discovery	The process that presents the initiator with a list of available targets.
Discovery method	The way in which the iSCSI targets can be found. Three methods are currently available: <ul style="list-style-type: none"> ■ Internet Storage Name Service (iSNS) – Potential targets are discovered by interacting with one or more iSNS servers. ■ SendTargets – Potential targets are discovered by using a <i>discovery-address</i>. ■ Static – Static target addressing is configured.
Initiator	The driver that initiates SCSI requests to the iSCSI target.
Initiator group	A set of initiators. When an initiator group is associated with a LUN, only initiators from that group may access the LUN.
iqn or eui address format	An iqn (iSCSI qualified name) address is the unique identifier for a device in an iSCSI network using the form <i>iqn.date.authority:uniqueid</i> . An iSCSI initiator or target is assigned an IQN name automatically when the iSCSI initiator or target is initialized. An eui (extended unique identifier) address consists of 16 hexadecimal digits, and identifies a class of GUIDs that is used in both the SCSI and InfiniBand standards. SRP devices use the eui address format.
Logical unit	A uniquely numbered component in a storage system. When a LUN is associated with one or more SCSI targets, the target can be accessed by one or more SCSI initiators.
Target device	The iSCSI storage component.
Target group	A set of targets. A can be made available to all targets in one target group.
Target portal group	A list of IP addresses that determines which interfaces a specific iSCSI target will listen to. A TPG contains IP addresses and TCP port numbers

Configuring Dynamic or Static Target Discovery

Determine whether you want to configure one of the dynamic device discovery methods or use static iSCSI initiator targets to perform device discovery.

- **Dynamic device discovery** – Two dynamic device discovery methods are available:
 - SendTargets – If an iSCSI node exposes a large number of targets, such as an iSCSI to Fibre-Channel bridge, you can supply the iSCSI node IP address/port combination

and allow the iSCSI initiator to use the SendTargets features to perform the device discovery.

- **iSNS** – The Internet Storage Name Service (iSNS) allows the iSCSI initiator to discover the targets to which it has access using as little configuration information as possible. It also provides state change notification to notify the iSCSI initiator when changes in the operational state of storage nodes occur. To use the iSNS discovery method, you can supply the iSNS server address/port combination and allow the iSCSI initiator to query the iSNS servers that you specified to perform the device discovery. The default port for the iSNS server is 3205. For more information about iSNS, see [Internet Storage Name Service \(iSNS\), RFC 4171](#).

The iSNS discovery service provides an administrative model to discover all targets on a network.

For more information about setting up iSNS support in Oracle Solaris, see [Chapter 9, “Configuring and Managing the Oracle Solaris Internet Storage Name Service \(iSNS\)”](#).

- **Static device discovery** – If an iSCSI node has a few targets or if you want to restrict the targets that the initiator attempts to access, you can statically configure the *target-name* by using the following static target address naming convention:

target,target-address[:port-number]

You can determine the static target address from the array's management tool.

Note - Do not configure an iSCSI target to be discovered by both static and dynamic device discovery methods. The consequence of using redundant discovery methods might be slow performance when the initiator is communicating with the iSCSI target device.

Configuring Storage Devices With COMSTAR

You can set up and configure a COMSTAR Internet SCSI (iSCSI) target and make it available over the network. The iSCSI features can work over a normal Internet connection (such as Ethernet) using the standard iSCSI protocol. The iSCSI protocol also provides naming and discovery services, authentication services using CHAP and RADIUS, and centralized management through iSNS.

If the system has at least one InfiniBand (IB) Host Channel Adapter (HCA) and connectivity exists between the initiator and the target, the iSCSI connection uses iSCSI Extensions for RDMA (iSER) for enhanced data throughput. iSER used with an IB HCA provides high bandwidth, low CPU utilization, and a single network connection that multiple protocols can share.

The iSER target and initiator both use a component called iSCSI Data Mover to provide iSCSI connection services. Use of iSER is automatic whenever both the initiator and the target are configured to use IP addresses that correspond to IB-capable devices.

▼ How to Enable the STMF Service

COMSTAR uses SMF to store its current, persistent configuration, such as logical unit mapping, host group definitions, and target group definitions. When the service is enabled during boot or when using the `svcadm` command, it clears any stale configuration data inside the kernel framework, and then reloads the configuration from the SMF repository into the driver. After the configuration is loaded, any changes that are made to the configuration are automatically updated inside the driver database, as well as inside the SMF repository. For example, any changes made through the `stmfadm` command are automatically updated in both areas.

The COMSTAR target mode framework runs as the `stmf` service. By default, the service is disabled. You must enable the service to use COMSTAR functionality. You can identify the service with the `svcs` command. If you have not rebooted the server since installing the `group/feature/storage-server` package, the service might not be enabled correctly.

1. Install the COMSTAR storage server software.

```
target# pkg install group/feature/storage-server
Packages to install: 75
Create boot environment: No
Services to restart: 7
DOWNLOAD                                PKGS      FILES    XFER (MB)
Completed                                75/75     9555/9555 105.7/105.7

PHASE                                     ACTIONS
Install Phase                             13347/13347

PHASE                                     ITEMS
Package State Update Phase                75/75
Image State Update Phase                   2/2
Loading smf(7) service descriptions: 17/17
Loading smf(7) service descriptions: 3/3

PHASE                                     ITEMS
Reading Existing Index                     8/8
Indexing Packages                          75/75
Indexing Packages                          75/75
Optimizing Index...
```

```
PHASE                                ITEMS
Indexing Packages                    573/573
```

2. Enable the stmf service.

```
target# svcadm enable stmf
target# svcs stmf
STATE          STIME      FMRI
online         09:42:32  svc:/system/stmf:default
```

▼ How to Back Up and Restore a COMSTAR Configuration

After you complete your COMSTAR configuration, make a copy that can be restored, if needed.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Export the current COMSTAR configuration.

```
# svccfg export -a stmf > COMSTAR.backup
```

3. If necessary, restore the exported configuration.

```
# svccfg import COMSTAR.backup
```

▼ How to Create a Logical Unit

The logical unit provider for creating disk-type LUs is called `sbdd`. However, you must initialize the storage for the logical unit before you can share a disk-type LU.

The disk volume provided by the server is referred to as the *target*. When the LU is associated with an iSCSI target, it can be accessed by an iSCSI initiator.

The process for creating SCSI LUs is as follows:

- Initialize the storage for the LU, also known as the *backing store*.
- Create a SCSI LU by using the backing store.

When a LU is created, it is assigned a global unique identifier (GUID), for example, 600144F0B5418B0000004DDAC7C10001. The GUID is used to refer to the LU in subsequent tasks, such as mapping a LU to select hosts.

The following steps are completed on the system that is providing the storage device.

1. **Create a ZFS storage pool.**

```
target# zpool create sanpool mirror c2t3d0 c2t4d0
```

2. **Create a ZFS volume to be used as a SCSI LU.**

```
target# zfs create -V 2g sanpool/vol1
```

3. **Create a LU for the ZFS volume.**

```
target# stmfadm create-lu /dev/zvol/rdisk/sanpool/vol1
Logical unit created: 600144F0B5418B0000004DDAC7C10001
```

You can find the device path for the ZFS volume in the `/dev/zvol/rdisk/pool-name/` directory.

4. **Confirm that the LU has been created.**

```
target# stmfadm list-lu
LU Name: 600144F0B5418B0000004DDAC7C10001
```

5. **Add the LU view.**

This command makes the LU accessible to all systems.

```
target# stmfadm add-view 600144F0B5418B0000004DDAC7C10001
```

If you want to restrict the LU view to specific systems, see [“How to Restrict Logical Unit Access to Selected Systems”](#) on page 162.

6. **Verify the LU configuration.**

```
target# stmfadm list-view -l 600144F0B5418B0000004DDAC7C10001
View Entry: 0
Host group   : All
Target group : All
LUN          : 0
```

▼ How to Create an iSCSI Target

This procedure assumes that you are logged in to the local system will contains the iSCSI target.

1. Enable the iSCSI target service.

```
target# svcadm enable -r svc:/network/iscsi/target:default
```

Confirm that the service is enabled.

```
target# svcs -l iscsi/target
fmri          svc:/network/iscsi/target:default
name          iscsi target
enabled       true
state         online
next_state    none
state_time    Fri Mar 20 09:47:15 PDT 2015
logfile       /var/svc/log/network-iscsi-target:default.log
restarter     svc:/system/svc/restarter:default
dependency    require_any/error svc:/milestone/network (online)
dependency    require_all/none svc:/system/stmf:default (online)
```

2. Create the iSCSI target.

```
target# itadm create-target
Target iqn.1986-03.com.sun:02:73d12edc-9bb9-cb44-efc4-c3b36c039405 successfully created
```

3. Display the iSCSI target information.

```
target# itadm list-target -v
TARGET NAME                               STATE   SESSIONS
iqn.1986-03.com.sun:02:73d12edc-9bb9-cb44-efc4-c3b36c039405  online  0
alias:                                     -
auth:                                       none (defaults)
targetchapuser:                             -
targetchapsecret:                           unset
tpg-tags:                                    default
```

▼ How to Configure CHAP Authentication for an iSCSI Target

You can set up either bidirectional or unidirectional CHAP authentication. This procedure assumes that you are logged in to the local system that contains the iSCSI targets.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Configure the target to require that initiators identify themselves by using CHAP authentication.

```
target# itadm modify-target -a chap target-iqn
```

3. Create an initiator context that describes the initiator with initiator's full node name and initiator's CHAP secret key.

```
target# itadm create-initiator -s initiator-iqn
Enter CHAP secret: *****
Re-enter secret: *****
```

4. If the initiator uses an alternate CHAP name, then configure the initiator-context with the alternate name.

```
target# itadm modify-initiator -u initiator-CHAP-name initiator-iqn
```

This step completes the setup of unidirectional CHAP authentication. Continue with the remaining steps if you want to set up bidirectional CHAP authentication.

5. Set the target device secret key that identifies this target.

```
target# itadm modify-target -s target-iqn
Enter CHAP secret: *****
Re-enter secret: *****
```

6. If the target uses a custom CHAP user name, set the CHAP name that identifies the target.

By default, the target's CHAP name is set to the target node name (iqn). If the target uses a custom name, set the CHAP name that identifies the target.

```
target# itadm modify-target -u target-CHAP-name target-iqn
```

▼ How to Configure a RADIUS Server for an iSCSI Target

This procedure assumes that you are logged in to the local system to securely access the configured iSCSI target device.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Configure the initiator node with the IP address and the port of the RADIUS server.

The default port is 1812. This configuration is completed once for all iSCSI targets on the target system.

```
initiator# itadm modify-defaults -r RADIUS-server-IP-address
Enter RADIUS secret: *****
Re-enter secret: *****
```

3. Configure the shared secret key that is used for communication between the target system and the RADIUS server.

```
initiator# itadm modify-defaults -d
Enter RADIUS secret: *****
Re-enter secret: *****
```

4. Configure the target system to require RADIUS authentication.

This configuration can be performed for an individual target or as a default for all targets.

```
initiator# itadm modify-target -a radius target-iqn
```

5. Configure the RADIUS server with the following information:

- The identity of the target node (for example, its IP address)
- The shared secret key that the target node uses to communicate with the RADIUS server
- The initiator's CHAP name (for example, initiator's iqn name) and the secret key for each initiator that needs to be authenticated

▼ How to Enable iSNS Discovery for the Target Device

Use this method if you have at least one iSNS server on your network. This method enables the iSCSI initiator to discover targets with as little configuration as possible, while also providing state-change notification. State-change functionality notifies the iSCSI initiator when there are changes in the operational state of a target. For this method, you must supply the iSNS server address and port combination. The iSCSI initiator can then query the specified iSNS server to perform device discovery. The default port for an iSNS server is 3205.

- 1. Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

- 2. Add the iSNS server information.**

```
target# itadm modify-defaults --isns-server ip-address
```

Identify the *ip-address* of the iSNS server in your network.

This step adds the iSNS server information to all of the Oracle Solaris iSCSI targets.

- 3. Enable iSNS server discovery.**

```
target# itadm modify-defaults --isns enable
```

▼ How to Configure an IB HCA for iSER

An InfiniBand (IB) Host Channel Adapter (HCA) is required to take full advantage of the iSCSI Extensions for RDMA (iSER) capabilities. To use iSER, you must configure the HCA on both the target and the initiator.

- 1. Become an administrator on the initiator.**

- 2. Connect the HCA to an IB switch.**

See the vendor documentation for details.

- 3. Configure the target and the initiator for the HCA.**

The target and the initiator must be on the same subnet. This example uses `ibd0` as the driver.

```
# ipadm create-ip ibd0
```

- 4. Configure the IP address and port combination for the HCA.**

```
# ipadm create-addr -T static -a local=203.0.113.141/24 ibd0/v4addr
```

- 5. Verify the interface configuration.**

```
# ipadm show-addr
ADDROBJ          TYPE      STATE      ADDR
lo0/v4           static    ok         127.0.0.1/8
e1000g0/_b       dhcp      ok         203.0.113.141/24
lo0/v6           static    ok         ::1/128
e1000g0/_a       addrconf ok         fe80::214:4fff:fe27:360c/10
```

6. **Become an administrator on the target system and repeat steps 3-5 for all other HCA hosts on the network.**
7. **Verify connectivity on both the target and the initiator.**

```
target# ping initiator-ip  
initiator# ping target-ip
```

Creating iSCSI Target Portal Groups

You can create a target portal group (TPG) to manage the discovery of multiple iSCSI and iSER targets. A TPG is a list of IP addresses to determine upon which interfaces a specific iSCSI target will listen.

A TPG contains IP addresses and TCP port numbers. To use this capability, you need to do the following:

- Create a TPG as a list of *ip-address:port* specifiers by using the `itadm create-tpg` command.
- Bind a specific iSCSI target to a TPG by using the `itadm modify-target -t` command.
- When an iSCSI target is made active, an iSCSI listener is created for each IP address and port belonging to a TPG associated with that target.

A TPG is an efficient way to control which targets are discovered through specific ports. For example, you could restrict your iSCSI target so that it is available only through one specific IP address or only through a set of iSER-capable IP addresses.

Note - Do not confuse target portal groups with target groups. A target group is a list of SCSI target ports that are all treated the same when creating views. Creating a view can help you facilitate LU mapping. Each view entry specifies a target group, a host group, and a LU. For more information about Target Groups and LUN mapping, see [“Making SCSI Logical Units Available” on page 160](#) and `stmfadm(8)`.

To learn about static and iSNS target discovery, see [“Configuring Dynamic or Static Target Discovery” on page 149](#). The iSCSI initiator uses the `iscsiadm` command to discover TPGs. For more information, see `iscsiadm(8)` and `itadm(8)`.

Using TPGs with iSER

When you use the SendTargets discovery and iSER at the same time, a common convention is to use a TPG to associate a specific iSCSI target port with only iSER-capable IP addresses. For

example, if a target system has four IP addresses, A, B, C, and D, and only addresses B and C are iSER-capable, then addresses B and C could be added to a TPG, and assigned to a target T.

An iSCSI initiator with both Ethernet and InfiniBand (IB) interfaces could use the SendTargets discovery method to discover the possible storage targets. Without the use of TPGs, the initiator might always prefer the use of the Ethernet interfaces over the IB interfaces. By associating target T only with the IB interfaces, the initiator correctly prefers using its IB-capable interface when connecting to target T.

▼ How to Create a Target Portal Group for iSCSI Targets

You can create a target portal group (TPG) by providing a unique name, and a TPG Tag (ranging from 2–65535) is automatically generated. TPG Tag 1 is reserved for the default TPG that is used when you do not explicitly set a TPG on the target. The portal for the default TPG matches requests from all network interfaces on port 3260.

The following steps shows how to create two TPGs, TPGA and TPGB, that use port 8000 for the IP addresses in TPGB.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Create two TPGs.

```
target# itadm create-tpg TPGA 192.0.2.1 192.0.2.2
target# itadm create-tpg TPGB 192.0.2.2:8000 192.0.2.2:8000
```

Note - IPv4 portals are specified in dotted address notation (for example, 192.0.2.1). IPv6 portal addresses must be enclosed in square brackets.

3. Configure an existing iSCSI target to use the TPGs, TPGA and TPGB.

```
# itadm modify-target -t TPGA,TPGB eui.20387ab8943ef7548
```

4. Verify the TPGs that you created.

```
# itadm list-tpg -v
```

You can remove a TPG with the `itadm delete-tpg` command.

▼ How to Access iSCSI Disks

After the devices have been discovered by the Oracle Solaris iSCSI initiator, the login negotiation occurs automatically. The Oracle Solaris iSCSI driver determines the number of available LUs and creates the device nodes. Then, the iSCSI devices can be treated as any other SCSI device.

You can create a ZFS storage pool on the LU and then create a ZFS file system.

You can view the iSCSI disks on the local system by using the `format` utility.

1. Review the iSCSI LU information in the `format` output.

```
initiator# format
0. c0t600144F0B5418B0000004DDAC7C10001d0 <SUN-COMSTAR-1.0 cyl 1022 alt 2 hd 128 sec 32>
   /scsi_vhci/disk@g600144f0b5418b0000004ddac7c10001
1. c8t0d0 <Sun-STK RAID INT-V1.0 cyl 17830 alt 2 hd 255 sec 63>
   /pci@0,0/pci10de,375@f/pci108e,286@0/disk@0,0
2. c8t1d0 <Sun-STK RAID INT-V1.0-136.61GB>
   /pci@0,0/pci10de,375@f/pci108e,286@0/disk@1,0
3. c8t2d0 <Sun-STK RAID INT-V1.0-136.61GB>
   /pci@0,0/pci10de,375@f/pci108e,286@0/disk@2,0
4. c8t3d0 <Sun-STK RAID INT-V1.0 cyl 17830 alt 2 hd 255 sec 63>
   /pci@0,0/pci10de,375@f/pci108e,286@0/disk@3,0
Specify disk (enter its number): 0
selecting c0t600144F0B5418B0000004DDAC7C10001d0
[disk formatted]
```

In the above output, disk 0 is an iSCSI LU under MPxIO control. Disks 1-4 are local disks.

2. You can create a ZFS storage pool and ZFS file systems on the iSCSI LU.

```
initiator# zpool create pool-name c0t600144F0B5418B0000004DDAC7C10001d0
initiator# zfs create pool-name/fs-name
```

The ZFS file system is automatically mounted when created and is remounted at boot time.

Making SCSI Logical Units Available

- [“How to Make a Logical Unit Available to All Systems” on page 161](#)
- [“How to Restrict Logical Unit Access to Selected Systems” on page 162](#)

Simply registering a logical unit (LU) with the STMF framework does not make it available to hosts (initiators) on the network. This section describes how to make LUs visible to initiator hosts for the following configurations.

For iSCSI, Fibre Channel, and FCoE configurations, a LU must be mapped before it can be accessed. You can choose one of the following methods, both of which use the `stmfadm` command:

- **Simple mapping** – Exposes the LU to all initiators through all the ports, using one command. Making LUs available to all hosts uses this method.
- **Selective mapping** – Enables you to specify the hosts that can access the LU. Making LUs available to selected hosts uses this method. This process includes the following steps:
 1. Defining host groups – A host group is a name given to a set of hosts (initiators) that are allowed to access the same LUs. This step is not needed if the same set of LUs is visible to all the hosts, as in simple mapping.
 2. Defining target groups – A target group is a name given to a set of target ports that export the same set of LUs to the same set of host groups. This step is not needed if the same set of LUs is visible to all the hosts, as in simple mapping.
 3. Adding one or more views for each logical unit – Adding a view creates a bridge between the LU and the host initiator. When an initiator from the host group logs in to a target port contained in the target group, the LU is visible.

Note - Don't confuse a target group with a target portal group (TPG). A TPG is a list of IP addresses that an iSCSI target listens to. A TPG can help you restrict an iSCSI target so that it is available only through one specific IP address. For more information about target groups, see [stmfadm\(8\)](#).

A view entry consists of four components: host group, target group, logical unit number (LUN), and LU identifier. Of these four components, only the LU identifier is required. If the other components are omitted, the following default values are assumed:

- If the host group is omitted, the all initiators value is assumed.
- If the target group is omitted, the all targets value is assumed.
- If the LUN is omitted, the system chooses a suitable LUN for the entry.

▼ How to Make a Logical Unit Available to All Systems

This procedure makes a LU available to all initiator hosts on a storage network.

1. **Obtain the Global Unique Identification (GUID) number for the LU.**

```
# stmfadm list-lu -v
```

2. **Add a view for the logical unit.**

```
# stmfadm add-view GUID-number
```

▼ How to Restrict Logical Unit Access to Selected Systems

Use this procedure to restrict LU access to selected hosts on a storage network. If you are using Fibre Channel ports, first identify the World Wide Names (WWN). Then, selectively map a logical unit number (LUN) to the ports on host-a, for example. A target group (targets-0) is also defined for a given set of target ports that export the same set of LUs to the same host group.

For information about configuring a target group, see [stmfadm\(8\)](#).

1. **Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. **Identify the Fibre Channel (FC) port on the initiator.**

```
initiator# fcinfo hba-port
HBA Port WWN: 210000e08b195dae
Port Mode: Initiator
Port ID: 0
OS Device Name: /dev/cfg/c8
Manufacturer: QLogic Corp.
Model: 375-3108-xx
Firmware Version: 03.03.28
FCode/BIOS Version: fcode: 1.13;
Serial Number: not available
Driver Name: qlc
Driver Version: 20100408-3.01
Type: unknown
State: offline
Supported Speeds: 1Gb 2Gb
Current Speed: not established
Node WWN: 200000e08b195dae
NPIV Not Supported
```

.
.
.

3. Create a host group.

```
target# stmfadm create-hg host-a
```

4. Add the WWNs identified in the preceding output as members of the host group.

```
target# stmfadm add-hg-member -g host-a wwn.210000e08b195dae wwn.210100e08b395dae
```

5. Create a target group.

```
target# stmfadm create-tg targets-0
```

6. Specify the target group members by adding the target names.

Each SCSI target can be a member of only one target group.

```
target# stmfadm add-tg-member -g targets-0 wwn.guid-number
```

7. Identify the GUID number for the LU.

```
target# stmfadm list-lu -v
```

8. Make the LU available by adding a view entry, specifying the host group name and the LU GUID number.

```
target# stmfadm add-view -h host-a -t targets-0 -n 1 guid-number
```

▼ How to Perform ZFS Rollback

COMSTAR logical units are often created on top of ZFS volumes (zvol). The following procedure describes how to backup and restore zvols or perform incremental restore on LU backend ZFS volume.

This example shows how to temporarily unload the LU from a framework, perform the ZFS rollback to restore the previous ZFS snapshot and then re-enable the COMSTAR LU.

Note - The given LU will be completely unavailable for hosts (initiators) during this procedure.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. **Unload the LU from framework, but keep the existing views.**

Note - Any existing data in the logical unit remains intact.

```
# stmfadm delete-lu -k 600144F0D6DCC400000057C586EA0001
```

3. **Perform the requested rollback operation.**

```
# zfs rollback rpool/iscsi_zvol_01@snapshot
```

4. **Import the LU and restore the original configuration.**

```
# stmfadm import /dev/zvol/rdsk/rpool/iscsi_zvol_01
```

Configuring Fibre Channel Devices With COMSTAR

You can set up and configure a COMSTAR target on a SPARC system or x86 system in a FC network environment and make it accessible to the storage network. Ensure that the logical unit has been created. For instructions, see [“How to Create a Logical Unit”](#) on page 152.

Configuring Fibre Channel Ports With COMSTAR

The Fibre Channel (FC) port provider can use the same HBAs that are used for the FC initiators. A given FC port can be used as an initiator or as a target, but not as both. You can also configure a dual port or quad port FC HBA so that a subset of the HBA ports is in target mode and the rest of the ports are in initiator mode.

The procedures in this section are specific to QLogic HBAs. The driver to use with HBAs in initiator mode is `qlc`, which is a QLogic driver. The `qlc` driver works only in initiator mode, and cannot be used for target mode. The COMSTAR driver for a target QLogic 4G HBA is `qlt`.

Because initiator mode and target mode use different drivers, the driver you attach to an HBA port defines its function as a target or initiator. You can specify a driver for all the ports by specifying the PCI device ID of the HBA. Or, you can configure the driver on a port-by-port basis. Both methods use the `update_drv` command and are described in this section. For more information, see [update_drv\(8\)](#).

▼ How to Display Existing FC Port Bindings

Before making changes to the HBA ports, first check the existing port bindings.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Display what is currently bound to the port drivers.

In this example, the current binding is `pciex1077,2432`.

```
# mdb -k
Loading modules: [ unix krtld genunix specfs ...
> ::devbindings -q qlc
30001617a08 pciex1077,2432, instance #0 (driver name: qlc)
300016177e0 pciex1077,2432, instance #1 (driver name: qlc)
> $q
```

▼ How to Set All FC Ports to a Specific Mode

This procedure changes all ports on all HBAs with a specific PCI device ID to target mode. The PCI device ID number binds a driver to a port, thereby setting all the HBA ports with that PCI device ID, for example, all QLogic 4G PCI express HBAs, to target mode.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Remove the current binding.

In this example, the `qlc` driver is actively bound to `pciex1077,2432`. You must remove the existing binding for `qlc` before you can add that binding to a new driver. Single quotation marks are required in this syntax.

```
# update_drv -d -i 'pciex1077,2432' qlc
Cannot unload module: qlc
Will be unloaded upon reboot.
```

This message does *not* indicate an error. The configuration files have been updated but the `qlc` driver remains bound to the port until the system is rebooted.

3. Establish the new binding.

In this example, `qlt` is updated. Single quotes are required in this syntax.

```
# update_drv -a -i 'pciex1077,2432' qlt
devfsadm: driver failed to attach: qlt
Warning: Driver (qlt) successfully added to system but failed to attach
```

This message does not indicate an error. The qlc driver remains bound to the port, until the system is rebooted. The qlt driver attaches when the system is rebooted.

4. Reboot the system to attach the new driver. Then, recheck the bindings.

```
# init 6
.
.
.
# mdb -k

Loading modules: [ unix krtld genunix specfs dtrace ...
> ::devbindings -q qlt
30001615a08 pciex1077,2432, instance #0 (driver name: qlt)
30001615e0 pciex1077,2432, instance #1 (driver name: qlt)
> $q
```

5. Verify that the target mode framework has access to the HBA ports.

```
# stmfadm list-target -v
Target: wwn.210100E08BA54E60
Operational Status : Offline
Provider Name : qlt(1)
Alias : -
Sessions : 0
Target: wwn.210100E08BA54E60
Operational Status : Offline
Provider Name : qlt(0)
Alias : -
Sessions : 0
```

▼ How to Set Selected FC Ports to Initiator or Target Mode

This procedure uses *path-based bindings*. It shows you how to use a specific device path to bind a port to a driver that is different from the driver to which it is currently bound.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Display a list of the HBA ports and their respective device paths.

This example shows the device paths for a two HBAs with four ports.

```
# cfgadm -v
Ap_Id                Receptacle  Occupant    Condition  Information
When                Type        Busy        Phys_Id
c2                   fc-fabric   n           connected  configured  unknown
unavailable         /devices/pci380/pci1/pci0/pci5/SUNW,qlc@0/
fp@0,0:fc
c3                   fc-fabric   n           connected  configured  unknown
unavailable         /devices/pci380/pci1/pci0/pci5/SUNW,qlc@0,1/
fp@0,0:fc
c4                   fc          n           connected  unconfigured unknown
unavailable         /devices/pci380/pci1/pci0/pci6/QLGC,qlc@0,2/
fp@0,0:fc
c5                   fc          n           connected  unconfigured unknown
unavailable         /devices/pci380/pci1/pci0/pci6/QLGC,qlc@0,3/
fp@0,0:fc
```

3. Set the second port to target mode, and leave the other ports in initiator mode.

Remove the initial `/devices` portion of the path, and include everything up to `/fp@0`. The path with the `/devices` portion removed is the path to which the system binds the `qlt` driver.

Single quotation marks are required in this syntax.

```
# update_drv -a -i '/pci380/pci1/pci0/pci5/SUNW,qlc@0,1' qlt
devfsadm: driver failed to attach: qlt
Warning: Driver (qlt) successfully added to system but failed to attach
```

This message does not indicate an error. The `qlc` driver remains bound to the port until reboot. The `qlt` driver attaches during reboot.

4. Reboot the system to attach the new driver. Then, recheck the bindings.

You should see that the port changed from initiator mode (`qlc`) to target mode (`qlt`).

```
# init 6
.
.
.
# mdb -k
.
.
.
> $q
```

5. Verify that the target mode framework has access to the HBA ports.

```
# stmfadm list-target -v
```

Making Logical Units Available for FC and FCoE

Simply registering a logical unit (LU) with the STMF framework does not make it available to hosts (initiators) on the network. You must make logical units visible to initiator hosts for Fibre Channel and FCoE configurations by mapping the logical unit. To determine which method to use and how to map the logical unit, see [“How to Make a Logical Unit Available to All Systems” on page 161](#). Both methods use the `stmfdm` command. The additional steps below are for FC and FCoE configurations.

▼ How to Make Logical Units Available for FC and FCoE

This procedure makes the LU available to all hosts or selected hosts for FC or FCoE configurations on a storage network. The steps are run on the host.

- 1. Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

- 2. Make a LU available to hosts.**

Obtain the global unique identification (GUID) number for the LU.

```
# sbdadm list-lu
# stmfdm list-lu -v
```

Identify the WWNs for the FC or FCoE ports of the host.

```
# fcinfo hba-port
HBA Port WWN: *210000e08b83378d*
OS Device Name: /dev/cfg/c4
Manufacturer: QLogic Corp.
Model: QLA2462
Firmware Version: 4.0.27
Fcode/BIOS Version: N/A
Type: N-port
State: online
Supported Speeds: 1Gb 2Gb 4Gb
Current Speed: 4Gb
Node WWN: 210000e08b83378d
HBA Port WWN: *210100e08ba3378d*
OS Device Name: /dev/cfg/c5
Manufacturer: QLogic Corp.
Model: QLA2462
Firmware Version: 4.0.27
```

```
Fcode/BIOS Version: N/A
Type: N-port
State: onLine
Supported Speeds: 1Gb 2Gb 4Gb
Current Speed: 4Gb
Node WWN: 210100e08ba3378d
```

3. Add a view and perform mapping.

Follow the instructions in [“How to Make a Logical Unit Available to All Systems”](#) on page 161.

4. Verify that the LU is visible on an Oracle Solaris initiator host by running the following script.

```
#!/bin/ksh
fcinfo hba-port |grep "^HBA" | awk '{print $4}' | while read ln
do
fcinfo remote-port -p $ln -s >/dev/null 2>&1
done
```

All subsequent LUNs appear in the format output, because the script forces the initiator to touch all the LUNs through all the ports. If you do not see the LUNs, run the format command again. If you still do not see the LUNs, ensure that the service is enabled on the target by using the `svcs stmf` command. Also ensure that you added view entries for the LU, as described in [“How to Make a Logical Unit Available to All Systems”](#) on page 161.

5. Verify that the LU is visible on other systems.

- For a Linux initiator host, verify that the LU is visible by running the utility provided by the HBA vendor. The utility scans for configuration changes.
- For a Windows initiator host, verify that the logical unit is visible by selecting Control Panel → Administrative Tools → Computer Management → Disk Management. Then, from the Action menu, choose Rescan Disks.

Configuring FCoE Devices With COMSTAR

You can set up and configure a COMSTAR target in a Fibre Channel over Ethernet (FCoE) network environment, then make it accessible to the storage network. Ensure that your system meets the necessary prerequisites before you begin:

- [“How to Create a Logical Unit”](#) on page 152
- [“How to Create an iSCSI Target”](#) on page 154

- [Chapter 5, “Configuring an Oracle Solaris iSCSI Initiator” in *Managing SAN Devices and I/O Multipathing in Oracle Solaris 11.4*](#)

Configuring FCoE Ports

- [“Enabling 802.3x PAUSE and Jumbo Frames on the Ethernet Interface” on page 170](#)
- [“How to Create FCoE Target Ports” on page 171](#)
- [“How to Verify That an FCoE Target Port Is Working” on page 171](#)
- [“How to Delete FCoE Target Ports” on page 172](#)

FCoE functionality is provided through Ethernet interfaces. Fibre Channel over Ethernet (FCoE) ports are logical entities associated with Ethernet interfaces. Within an Oracle Solaris system, a one-to-one mapping of FCoE ports and Ethernet interfaces exist. You can associate only one FCoE port with a given Ethernet interface. FCoE and IP cannot share the same Ethernet interface. So, before you create an FCoE port on an Ethernet interface, ensure that the interface has been unplumbed.

The FCoE port configuration is persistent across reboots. All configured FCoE ports are created and placed online automatically after the system reboots.

For FCoE target ports, you must enable the following service before creating FCoE target ports to get persistent behavior.

```
# svcadm enable svc:/system/fcoe_target:default
```

Enabling 802.3x PAUSE and Jumbo Frames on the Ethernet Interface

These settings can vary for different Ethernet hardware and drivers. In most cases, you must modify the `driver.conf` file of the Ethernet interface and then reboot. See the `driver.conf` file for your Ethernet interface for details on how to enable these features.

Perform one of the following prerequisite steps before you create an FCoE port on an Ethernet interface:

- Enable 802.3x (also called PAUSE) on the Ethernet interface.
Doing so ensures a consistent Ethernet transport.
- Enable jumbo frames (> 2.5 Kbyte) on the Ethernet interface.
A Fibre Channel data frame can be as large as 2136 bytes.

▼ How to Create FCoE Target Ports

1. **Create an FCoE target port on a specified network interface.**

```
# fcadm create-fcoe-port -t nxge0
```

If the Ethernet interface you selected does not support multiple unicast address (for example, the VMware network interface), you are prompted to explicitly enable promiscuous mode on that interface.

2. **Enable promiscuous mode, if prompted.**

```
# fcadm create-fcoe-port -t -f e1000g0
```

If no error messages appear, the FCoE target port is created, and the FCoE target is online.

▼ How to Verify That an FCoE Target Port Is Working

1. **Display the FCoE ports that you created.**

```
# fcadm list-fcoe-ports
HBA Port WWN: 200000144fda7f66
Port Type: Target
MAC Name: nxge0
MTU Size: 9194
MAC Factory Address: 00144fda7f66
MAC Current Address: 0efc009a002a
Promiscuous Mode: On
```

2. **Display all target mode Fibre Channel HBA ports on the host.**

```
# fcinfo hba-port -t
HBA Port WWN: 200000144fda7f66
Port Mode: Target
Port ID: 9a002a
OS Device Name: Not Applicable
Manufacturer: Sun Microsystems, Inc.
Model: FCoE Virtual FC HBA
Firmware Version: N/A
FCode/BIOS Version: N/A
Serial Number: N/A
Driver Name: COMSTAR FCOET
Driver Version: 1.0
Type: F-port
State: online
```

```
Supported Speeds: 1Gb 10 Gb
Current Speed: 10Gb
Node WWN: 100000144fda7f66
```

3. View a list of the FCoE target ports.

The `-v` option displays additional information about the target, along with SCSI session information for logged-in initiators.

```
# stmfadm list-target -v
Target wwn.200000144FDA7F66
Operational Status: Online
Provider Name      : fcoet
Alias              : fcoet1
Sessions          : 1
Initiator: wwn.210000E08B818343
Alias: #QLA2342 FW:v3.03.25 DVR:v8.02.14.01
Logged in since: ...
```

▼ How to Delete FCoE Target Ports

You can disable FCoE functionality when needed.

1. Take the FCoE target port offline.

```
# stmfadm offline-target wwn.200000144fda7f66
```

2. Remove the FCoE target port.

```
# fcadm delete-fcoe-port nxge0
```

Configuring SRP Devices With COMSTAR

The SCSI RDMA Protocol accelerates the SCSI protocol by mapping the SCSI data transfer phases to Infiniband (IB) Remote Direct Memory Access (RDMA) operations. As a result, an SRP initiator can read and write data from a COMSTAR SRP target at high data rates with relatively low CPU utilization.

You can set up and configure a COMSTAR SRP target and make it available over an Infiniband (IB) fabric. The SRP target is available wherever a supported IB Host Channel Adapter (HCA) is installed on the target system.

- **One SCSI target per IB HCA** – The COMSTAR SRP target uses a simple model in which each supported IB HCA is registered as a SCSI target. The SCSI target is a virtual object that contains a task router and acts as the connection between the SCSI transport (in this case, SRP) and the SCSI back end (STMF and SBD).

An HCA can contain multiple physical ports. The same SCSI target is shared between all the ports of an HCA. The SCSI target representing the HCA is automatically available for incoming connections through all the active ports of that HCA.

- **SRP target eui identifier** – In the IB architecture, each HCA and each port is assigned a 64-bit GUID by the manufacturer. The COMSTAR SCSI target created for each HCA is given a name corresponding to the GUID of that HCA, which has the format: `eui.HCA-GUID`. For example, if the target system includes a supported IB HCA with an HCA GUID of `0003BA0001002E48`, then a SCSI target will be created using the name `eui.0003BA0001002E48`. The string `eui` stands for *extended unique identifier* and names a class of GUIDs that is used in both the SCSI and IB standards.
- **SRP initiator eui identifier** – Similarly, SRP uses a 64-bit initiator GUID to identify the initiator system. The choice of which GUID to use is determined by the SRP initiator implementation. Many initiators use the GUID of the HCA that is being used for the outgoing connection. For example, an initiator using the GUID of `0003BA0001002EA5` is known to COMSTAR as `eui.0003BA0001002EA5`.

Using COMSTAR Views With SRP

The COMSTAR view facility can be used to create target groups and host groups that restrict and configure which logical units (LUs) can be accessed through each SCSI target or initiator as described in [“Making SCSI Logical Units Available” on page 160](#). The `eui` identifier of the SRP initiator is added to a host group. The `eui` identifier of the SRP SCSI Target is added to a target group. The view entries for each LU then determine the particular set of LUs that each initiator can access.

▼ How to Enable the SRP Target Service

The COMSTAR port provider for the COMSTAR SRP target is managed by the Service Management Facility (SMF). The primary SRP target service is `svc:/system/ibsrp/target:default`, which can be abbreviated to `ibsrp/target`.

The SRP package is `storage/scsi-rdma/scsi-rdma-target`.

1. **Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. **Recursively enable the SRP target service.**

```
# svcadm enable -r ibsrp/target
```

3. **Display the SRP target service information.**

```
# svcs -l ibsrp/target
```

▼ How to Verify SRP Target Status

1. **Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. **Verify the presence of the expected SRP SCSI target on the system.**

```
# srptadm list-target
Target HCA 21280001A0D0F0:
Enabled           : true
SRP Target Name   : eui.0021280001A0D0F0
Operational Status : online
```

Configuring and Managing the Oracle Solaris Internet Storage Name Service (iSNS)

This chapter provides an overview of the Internet Storage Name Service (iSNS), and describes how to configure the Oracle Solaris iSNS server, manage the iSNS server, and manage iSNS clients.

This is a list of the information in this chapter:

- [“About the iSNS Technology” on page 175](#)
- [“Configuring the iSNS Server” on page 177](#)
- [“Managing the iSNS Server and Clients” on page 187](#)

About the iSNS Technology

The Internet Storage Name Service (iSNS) is a protocol that allows dynamic discovery of iSCSI initiators and targets within an IP storage area network (SAN). The iSNS protocol enables identification, connection to, and management of iSCSI devices by providing the following services:

- **Name registration and discovery:** The source of data that is to be stored (known as the *initiator*) and the storage object (known as the *target*) register their attributes and address, and can obtain information about accessible storage devices dynamically.
- **Discovery domains and logon control:** Resources in a typical storage network are divided into groups called *discovery domains*, which can be administered through network management applications. Discovery domains enhance security by providing access control to targets that are not enabled with their own access controls, while limiting the logon process of each initiator to a relevant subset of the available targets in the network.
- **State-change notification:** The iSNS server notifies relevant iSNS clients about the network events such as, a newly created disk Logical Unit Number (LUN), storage resources going offline, discovery domain membership changes and link failures in a

network. These notifications let a network quickly adapt to changes in topology, which is key to scalability and availability. This is an optional service.

- **Entity status inquiry:** The iSNS server verifies that a iSNS client is available. As a result, a status change notification might be issued. This is an optional service.

In a simple configuration, the source of data that is to be stored (the initiator) exchanges data with a storage object (the target). The initiator can locate the target and the target always recognizes the initiator. For example, the Oracle StorageTek 5320 Network Attached Storage (NAS) appliance is a iSCSI target because it stores data. The data comes from various iSCSI clients such as data management applications or network interface cards which act as initiators. However, in large and complex configurations, it is difficult and time-consuming to configure every initiator for every target and for every target to recognize every initiator. The iSNS server resolves this by using discovery and security mechanisms to dynamically and automatically identify initiators and targets, and manage their connections to authorized resources.

After an Oracle Solaris system has been configured as an iSNS server, all targets and initiators can register with the server. The targets and initiators become iSCSI *clients* or *nodes* of the iSNS server. These clients are members of the *default discovery domain*, the only domain in the *default discovery domain set*. When you enable the default discovery domain set, the iSNS server can provide the iSCSI Name Service (iSNS) for the clients in a simple manner.

To take advantage of the iSCSI Name Service's abilities, create several discovery domain sets and discovery domains. Then assign the clients to different domains, overlapping their memberships. The iSNS server keeps track of the clients' status as a member of one or more discovery domains. For example, when a new storage device is added to the storage network and is registered with the iSNS server, it is in the default discovery domain in the default discovery domain set. You then assign this target to the discovery domains whose initiators will use it as a resource. The iSNS server then removes this target as a member of the default discovery domain in the default discovery domain set.

All initiators and targets are assigned to at least one discovery domain. Assigning an initiator to one discovery domain restricts its access to those targets in the same discovery domain set. Assigning an initiator to several discovery domains allows it to find and use targets in all of the discovery domain sets that include the initiator's discovery domain. You can manage access to clients by disabling and enabling their discovery domain sets without affecting the clients in other discovery domain sets.

For example, a site has two discovery domain sets in addition to the default one: Production and Research. Within the two discovery domain sets are three domains in addition to the default one: Development, Operations, and Finance. The Development discovery domain is in the Research discovery domain set, Operations is in the Production domain set, and Finance is a member of both discovery domain sets. Each client has been assigned to the discovery domain set that uses it the most. A data application in the Operations discovery domain can locate and get access to storage devices in the Production discovery domain set because it is a member of that discovery domain set but it cannot get access to a storage device in the Research discovery

domain set. A data application in the Finance discovery domain can locate storage devices in both the Production and Research discovery domain sets because it is a member of both sets. If the Research discovery domain set were disabled, initiators in the Finance discovery domain would not have access to the Research storage devices but would continue to have access to those in the Production discovery domain set.

Configuring the iSNS Server

You can configure the iSNS server using the following task maps and sections.

<p>1. Accept the default properties of the iSNS server or change them.</p> <p>A. Notification of state changes of the server</p> <p>B. Number of attempts to determine a client's availability</p> <p>C. Location of file that stores</p>	<p>“How to Set Notifications for Changes in Server State” on page 180</p> <p>“How to Set the Number of Retries for Client Inquiries” on page 181</p> <p>“How to Specify the Data Store Location” on page 182</p>
---	--

client data	
2. Enable the iSNS server and display the settings.	<p>“How to Install the iSNS Server Package” on page 180</p> <p>“How to Display the Current Server Configuration” on page 183</p>
3. Register all clients with the iSNS server.	<p>Use the client's management interface's iSCSI configuration function to specify the IP address of the iSNS server and to allow discovery.</p>
4. Enable the default discovery domain set.	<p>“How to Enable the Default Discovery Domain Set” on page 183</p>

After these tasks, the iSNS server is operating in a minimal manner. All of the clients are in the default discovery domain and are unassigned. Each client can identify and get access to all of the other clients.

5. Create the discovery domain sets for your site.	<p>“How to Create the Discovery Domain Sets” on page 183</p>
6. Create the discovery domains for your site.	<p>“How to Create the Discovery Domains” on page 184</p>

<p>7. “How to Add a Discovery Domain to a Discovery AddDomain Set” on page 185</p> <p>each discovery domain to one or more discovery domain sets.</p>	
<p>8. “How to Assign Clients to a Discovery Domain” on page 186</p> <p>clients to one or more discovery domains.</p>	
<p>9. “How to Display the Status of a Discovery Domain Set” on page 187</p> <p>Verify the membership of clients in discovery domains and the membership of discovery domains in discovery domain sets.</p> <p>“How to Display the Status of a Discovery Domain” on page 188</p> <p>“How to Display the Status of Clients” on page 188</p>	

The next section provides instructions for setting up the iSNS environment. The following topics are discussed:

- [“Setting Up the iSNS Administrative Settings”](#) on page 180
- [“Using the Command Line Interface to Configure iSNS”](#) on page 182

Setting Up the iSNS Administrative Settings

This section provides the procedures for changing the default administrative settings of the iSNS service and for starting the iSNS daemon. If you change a setting after the iSNS server has been started, you need to refresh the iSNS server. If you change the data store location, you need to restart the iSNS server.

The following tasks are described in this section:

- “How to Install the iSNS Server Package” on page 180
- “How to Set Notifications for Changes in Server State” on page 180
- “How to Set the Number of Retries for Client Inquiries” on page 181
- “How to Specify the Data Store Location” on page 182

For more information about these operations, see the [isns\(8\)](#) man page.

▼ How to Install the iSNS Server Package

Install the iSNS server package and start the iSNS service.

1. **Become an administrator.**
2. **Install the iSNS server package.**

```
# pkg install service/storage/isns
```

3. **Enable the iSNS service.**

```
# svcadm enable isns_server
```

4. **Verify that the service is running.**

```
# svcs svc:/network/isns_server:default
STATE          STIME      FMRI
online         16:10:49  svc:/network/isns_server:default
```

▼ How to Set Notifications for Changes in Server State

By default, all clients are notified when the iSNS server is not available. To disable these notifications, change the `Management_SCNs_Enabled` property.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Use the `svccfg` command to disable the property:

```
# svccfg -s svc:/network/isns_server setprop config/Management_SCN_Enabled=false
```

3. Reload the server configuration:

```
# svcadm refresh svc:/network/isns_server
```

▼ How to Set the Number of Retries for Client Inquiries

The default number of retries is 3. If the server does not get a response to three inquiries, it registers that client as unavailable. To change the number of retries, change the value of the `ESI Retry Threshold` property.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Use the `svccfg` command to change the property to, for example, 6 retries:

```
# svccfg -s svc:/network/isns_server setprop config/ESI_retry_threshold_count=6
```

3. Reload the server configuration:

```
# svcadm refresh svc:/network/isns_server
```

▼ How to Specify the Data Store Location

The default location and name for the file that contains the client data is `/etc/isns/isnsdata.xml`. If you have a complex network environment that includes one or more backup iSNS servers, the data store must reside in a common location so that all servers can use it. Use the `data_store_location` property to specify the new location. You can also change the name of the file.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Use the `svccfg` command to change the location to. For example, change the location to `/etc/isns2/isns_data.xml`:

```
# svccfg -s svc:/network/isns_server setprop config/data_store_location="/etc/isns2/isns_data.xml"
```

3. If you change the data store location after the server has been enabled, you must restart the server:

```
# svcadm restart svc:/network/isns_server
```

Using the Command Line Interface to Configure iSNS

This section provides the procedures for configuring the iSNS server using the command line interface.

The following tasks are described in this section:

- [“How to Display the Current Server Configuration”](#) on page 183
- [“How to Enable the Default Discovery Domain Set”](#) on page 183
- [“How to Create the Discovery Domain Sets”](#) on page 183

- [“How to Create the Discovery Domains” on page 184](#)
- [“How to Add a Discovery Domain to a Discovery Domain Set” on page 185](#)
- [“How to Assign Clients to a Discovery Domain” on page 186](#)

These procedures use the `isnsadm(8)` command. See the man page for a complete description of all of the command options.

▼ How to Display the Current Server Configuration

- The following command shows the properties of the iSNS server:

```
# isnsadm show-config
Data Store Location: /etc/isns/isnsdata.xml
Entity Status Inquiry Non-Response Threshold: 3
Management SCN Enabled: yes
Authorized Control Node Names: -
```

▼ How to Enable the Default Discovery Domain Set

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Activate the default discovery domain set:

```
# isnsadm enable-dd-set Default
```

▼ How to Create the Discovery Domain Sets

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`

- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Create a discovery domain set:

```
# isnsadm create-dd-set set_name
```

3. Enable the discovery domain set:

```
# isnsadm enable-dd-set set_name
```

4. View all the discovery domain sets, including the new one:

```
# isnsadm list-dd-set -v
DD Set name: Default
State: Enabled
DD Set name:set_name
State: Enabled
```

The list of discovery domain sets includes the default discovery domain set as well as the new one.

▼ How to Create the Discovery Domains

New discovery domains are members of the default discovery domain set. After you create them, you must add the discovery domains to the new discovery domain set.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Create the discovery domain:

```
# isnsadm create-dd domain_name
```

3. View the new discovery domain in the Default discovery domain set:

```
# isnsadm list-dd-set
DD name: name
DD set(s): Default
```

4. Create other discovery domains.

▼ How to Add a Discovery Domain to a Discovery Domain Set

This task removes the discovery domain from the default discovery domain set and adds it the discovery domain set that you specify. Because the new discovery domain set has been enabled, all the clients in its discovery domains can be discovered by the iSNS server.

You need not have privileges to list the members of the discovery domains and discovery domain sets.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. List the discovery domains to identify the one you want to add.

```
# isnsadm list-dd -v
```

3. List the discovery domain sets to identify the one you want as the container for the new discovery domain.

```
# isnsadm list-dd-set
```

4. Move the discovery domain to the discovery domain set that you want:

```
# isnsadm add-dd domain_name -s set_name
```

5. View the new addition to the discovery domain set:

```
# isnsadm list-dd-set -v domain_name
```

▼ How to Assign Clients to a Discovery Domain

Before You Begin Use the management interface of the client to register the client. Using the iSCSI configuration function, specify the IP address of the iSNS server and allow discovery of the client by the iSNS server.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Verify that the client has been registered with the iSNS server:

```
# isnsadm list-node
iSCSI Name: iqn.1986-03.com.sun:01:000e0c9f10da.45173FEA.engr
Alias: STK5320_NAS
Type: Target
.
iSCSI Name: iqn.1986-03.com.sun:01:000e0c9f10da.454F00A2.acct
Alias:
Type: Initiator
```

The output shows the clients' iSCSI names.

3. Verify the name of the discovery domain:

```
# isnsadm list-dd
```

4. Add the client to the discovery domain:

```
# isnsadm add-node -d domain_name iSCSI_Name
```

For example, to add the target called "STK5320_NAS" to the Eng-dd discovery domain:

```
# isnsadm add-node -d Eng-dd iqn.1986-03.com.sun:01:000e0c9f10da.454F00A2.engr
```

5. List all the clients in the discovery domain to verify the client has been added:

```
# isnsadm list-dd -v domain_name
```

For example, to check the Eng-dd discovery domain:

```
# isnsadm list-dd -v Eng-dd
DD name: Eng-dd
DD set: Development-dds
iSCSI Name: iqn.1986-03.com.sun:01:000e0c9f10da.45173FEA.engr
iSCSI Name: iqn.1986-03.com.sun:01:000e0c9f10da.454F00A2.acct
iSCSI name: iqn.1986-03.com.sun:01:e00000000000.46fd8e2b
```

Managing the iSNS Server and Clients

This section describes how to maintain the iSNS discovery domain sets and their members, the initiators and targets.

As the site grows, continue to add clients, discovery domains, and discovery domain sets as described in the following sections:

- [“How to Create the Discovery Domain Sets” on page 183](#)
- [“How to Create the Discovery Domains” on page 184](#)
- [“How to Add a Discovery Domain to a Discovery Domain Set” on page 185](#)
- [“How to Assign Clients to a Discovery Domain” on page 186](#)

This section provides the other procedures for managing the iSNS server, using the command line interface.

The following tasks are described in this section:

- [“How to Display the Status of a Discovery Domain Set” on page 187](#)
- [“How to Display the Status of a Discovery Domain” on page 188](#)
- [“How to Display the Status of Clients” on page 188](#)
- [“How to Remove a Client from a Discovery Domain” on page 188](#)
- [“How to Remove a Discovery Domain from a Discovery Domain Set” on page 189](#)
- [“How to Disable a Discovery Domain Set” on page 189](#)
- [“How to Remove a Discovery Domain Set” on page 190](#)

▼ How to Display the Status of a Discovery Domain Set

- **Show the status of the discovery domain set and list the discovery domains that are its members:**

```
# isnsadm list-dd-set -v set_name
```

▼ How to Display the Status of a Discovery Domain

- Show the status of the discovery domain and lists the clients that are its members:

```
# isnsadm list-dd -v domain_name
```

▼ How to Display the Status of Clients

- Select one of the following to display client status:

- Show the status of all clients:

```
# isnsadm list-node -v
```

- Show the status of only the clients that are targets, that is, storage objects:

```
# isnsadm list-node -t
```

▼ How to Remove a Client from a Discovery Domain

1. You must be assigned the following authorizations when managing the iSNS service:

- solaris.isnsmgr.write
- solaris.smf.manage.isns
- solaris.smf.value.isns

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. List the clients to identify the one you want to remove.

```
# isnsadm list-node -v
iSCSI Name: iqn.1986-03.com.sun:01:000e0c9f10da.45173FEA.engr
Alias: STK5320_NAS
```

```
Type: Target
Network Entity: SE5310
Portal: 198.51.100.95:3260
Portal Group: 1
Portal: 198.51.100.95:3260
Portal Group: 1
DD Name: Research,Finance
```

The output shows the client's iSCSI name and the name of the discovery domains of which it is a member.

3. Remove the client from the discovery domain.

```
# isnsadm remove-node -d domain_name iSCSI_name
```

▼ How to Remove a Discovery Domain from a Discovery Domain Set

1. You must be assigned the following authorizations when managing the iSNS service:

- solaris.isnsmgr.write
- solaris.smf.manage.isns
- solaris.smf.value.isns

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. List the discovery domains to identify the one you want to remove.

```
# isnsadm list-dd -v
```

3. Remove the discovery domain from the discovery domain set.

```
# isnsadm remove-dd set_name domain_name
```

▼ How to Disable a Discovery Domain Set

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. Deactivate a discovery domain set:

```
# isnsadm disable-dd-set set_name
```

3. Verify that the state of the discovery domain set has changed to Disabled:

```
# isnsadm list-dd-set set_name
```

▼ How to Remove a Discovery Domain Set

After you remove a discovery domain set, its discovery domains remain. A discovery domain must be a member of at least one discovery domain set.

1. You must be assigned the following authorizations when managing the iSNS service:

- `solaris.isnsmgr.write`
- `solaris.smf.manage.isns`
- `solaris.smf.value.isns`

For information about assigning authorizations to a role, see [Chapter 3, “Assigning Rights in Oracle Solaris”](#) in *Securing Users and Processes in Oracle Solaris 11.4*.

2. List the discovery domain sets to identify the one you want to remove.

```
# isnsadm list-dd-set -v
```

3. Remove the discovery domain set.

```
# isnsadm remove-dd-set set_name
```

Managing Tape Drives Tasks

This chapter describes how to manage tape drives in the Oracle Solaris OS. It also includes the following topics:

- “Choosing Which Media to Use” on page 191
- “Backup Device Names” on page 192
- “Displaying Tape Drive Status” on page 193
- “Handling Magnetic Tape Cartridges” on page 194
- “Guidelines for Drive Maintenance and Media Handling” on page 194

This is a list of the step-by-step instructions in this chapter.

- “How to Display Tape Drive Status” on page 193
- “Retensioning a Magnetic Tape Cartridge” on page 194
- “Rewinding a Magnetic Tape Cartridge” on page 194

Choosing Which Media to Use

Oracle Solaris systems are generally backed up by using 1/2-inch tape cartridge devices or high capacity devices. You can review Oracle's current tape product line in [Oracle StorageTek Solutions](https://www.oracle.com/storage/tape-storage/) (<https://www.oracle.com/storage/tape-storage/>). Select the Resources tab.

See Oracle's current tape storage documentation in [Tape Storage Products Documentation Library](https://docs.oracle.com/cd/F24623_01/index.html) (https://docs.oracle.com/cd/F24623_01/index.html).

The media that you choose depends on the availability of the equipment that supports it and of the media (usually tape) that you use to store the files. Although you must do the backup from a local system, you can write the files to a remote device.

Backup Device Names

You specify a tape or device to use for backup by supplying a logical device name. This name points to the subdirectory that contains the "raw" device file and includes the logical unit number of the drive. Tape drive naming conventions use a logical, not a physical, device name, as follows: `/dev/rmt/N[d][b][n]`.

<code>/dev/rmt</code>	Raw magnetic tape subdirectory of the devices directory.
<code>n</code>	Drive number, with 0 as the first drive and <i>n</i> as the last drive.
<code>d</code>	Density which you can optionally specify by selecting one from the following choices: <ul style="list-style-type: none">▪ <code>l</code> – low▪ <code>m</code> – medium▪ <code>h</code> – high▪ <code>u</code> – ultra▪ <code>c</code> – compressed
<code>b</code>	Optional character if you want to indicate the tape's BSD compatible behavior.
<code>n</code>	Optional character if you want to specify <i>no-rewind</i> . Omit this character to specify the default behavior, which is <i>rewind</i> .

If you don't specify the density, a tape drive typically writes at its *preferred* density, which is typically the highest density the tape drive supports. Most SCSI drives can automatically detect the density or format on the tape and read it accordingly. To determine the different densities that are supported for a drive, look at the `/dev/rmt` subdirectory. This subdirectory includes the set of tape device files that support different output densities for each tape.

Also, a SCSI controller can have a maximum of seven SCSI tape drives.

The following are examples of tape device names with corresponding rewind and density values.

- `/dev/rmt/0` – first drive, rewind. Preferred density is used.
- `/dev/rmt/0n` – first drive, no rewind. Preferred density is used.
- `/dev/rmt/1m` – second drive, medium density, rewind.
- `/dev/rmt/1hn` – second drive, high density, no rewind.

Displaying Tape Drive Status

You can use the status option with the mt command to get status information about tape drives. The mt command reports information about any tape drives that are described in the `/kernel/drv/st.conf` file.

▼ How to Display Tape Drive Status

1. Ensure that tapes are loaded into the drives.
2. Type the following command, to check the status of every tape:

```
# mt -f /dev/rmt/drive-number status
```

Example 57 Displaying Tape Drive Status

The following example shows the status for a QIC-150 tape drive (`/dev/rmt/0`):

```
$ mt -f /dev/rmt/0 status
Archive QIC-150 tape drive:
sense key(0x0)= No Additional Sense   residual= 0   retries= 0
file no= 0   block no= 0
```

The following example shows the status for an Exabyte tape drive (`/dev/rmt/1`):

```
$ mt -f /dev/rmt/1 status
Exabyte EXB-8200 8mm tape drive:
sense key(0x0)= NO Additional Sense residual= 0   retries= 0
file no= 0   block no= 0
```

The following example shows a quick way to poll a system and locate all of its tape drives:

```
$ for drive in 0 1 2 3 4 5 6 7
> do
> mt -f /dev/rmt/$drive status
> done
Archive QIC-150 tape drive:
sense key(0x0)= No Additional Sense   residual= 0   retries= 0
file no= 0   block no= 0
/dev/rmt/1: No such file or directory
/dev/rmt/2: No such file or directory
/dev/rmt/3: No such file or directory
/dev/rmt/4: No such file or directory
/dev/rmt/5: No such file or directory
```

```
/dev/rmt/6: No such file or directory
/dev/rmt/7: No such file or directory
$
```

Handling Magnetic Tape Cartridges

If errors occur when a tape is being read, you can retension the tape, clean the tape drive, and then try again.

Retensioning a Magnetic Tape Cartridge

Retension a magnetic tape cartridge with the `mt` command.

For example:

```
$ mt -f /dev/rmt/1 retension
```

Note - Do not retension non-QIC tape drives.

Rewinding a Magnetic Tape Cartridge

To rewind a magnetic tape cartridge, use the `mt` command.

For example:

```
$ mt -f /dev/rmt/1 rewind
```

Guidelines for Drive Maintenance and Media Handling

A backup tape that cannot be read is useless. So, periodically clean and check your tape drives to ensure correct operation. See your hardware manuals for instructions on procedures for cleaning a tape drive. You can check your tape hardware by copying some files to the tape, reading the files back, and then comparing the original files with the copied files.

Be aware that hardware can fail in ways that the system does not report.

Always label your tapes after a backup. This label should never change. Every time you do a backup, make another tape label that contains the following information:

- The backup date
- The name of the physical machine and file system that is backed up
- The backup level
- The tape number (1 of n , if the backup spans multiple volumes)
- Any information specific to your site

Store your tapes in a dust-free safe location, away from magnetic equipment. Some sites store archived tapes in fireproof cabinets at remote locations.

You should create and maintain a log that tracks which media (tape volume) stores each job (backup) and the location of each backed-up file.

◆◆◆ CHAPTER 11

Writing CDs and DVDs

This chapter provides step-by-step instructions for writing and copying data CDs and DVDs and audio CDs using the `cdwr` command. This chapter includes the following topics:

- “Working With Audio CDs and Data CDs and DVDs” on page 197
- “Writing CD and DVD Data and Audio CDs” on page 199

Working With Audio CDs and Data CDs and DVDs

You can use the `cdwr` command in the `media/cdwr` package to write file systems for CDs and DVDs in ISO 9660 format with Rock Ridge or Joliet extensions on CD-R, CD-RW, DVD-RW, or DVD+RW media devices.

You can use the `cdwr` command to perform the following tasks:

- Create data CDs and DVDs.
- Create audio CDs.
- Extract audio data from an audio CD.
- Copy CDs and DVDs.
- Erase CD-RW media.

For information about recommended CD-R or CD-RW devices, go to [Oracle Hardware Compatibility List \(https://www.oracle.com/webfolder/technetwork/hcl/index.html\)](https://www.oracle.com/webfolder/technetwork/hcl/index.html).

CD/DVD Media Commonly Used Terms

This section defines commonly used terms related to CD/DVD media.

Term	Description
CD-R	CD read media that can be written once and after that, can only be read.
CD-RW	CD rewritable media that can be written to and erased. CD-RW media can only be read by CD-RW devices.
DVD-R	Digital video disk (recordable) that can be written once and after that, can only be read. These devices have much larger capacity than CD-R media.
DVD+R	Digital video disk (recordable) that can be written once and after that, can only be read. DVD+R devices have more complete error management system than DVD-R, which allows more accurate burning to media, independent of the quality of the media.
DVD-RW	Digital video disk (rewritable) with storage capacity equal to a DVD-R. This media can be re-recorded after erasing the entire disk.
DVD+RW	Digital video disk (random-access rewritable) with storage capacity equal to a DVD+R. This medium allows overwriting of individual blocks without erasing the entire disk.
DVD-RAM	Digital video disk (random access memory, rewritable) with circular rather than spiral tracks and hard sectoring.
ISO 9660	ISO, an acronym for Industry Standards Organization, is an organization that sets standards for computer storage formats. An ISO 9660 file system is a standard CD or DVD file system that enables you to read the same CD or DVD on any major computer platform. The standard, issued in 1988, was written by an industry group named High Sierra, named after the High Sierra Hotel in Nevada. Almost all computers with CD or DVD drives can read files from an ISO 9660 file system.
Joliet extensions	Adds Windows file system information.
Rock Ridge extensions	Adds UNIX file system information. (Rock Ridge is named after the town in the movie Blazing Saddles.) Note - These extensions are not mutually exclusive. You can specify both <code>mkisofs -R</code> and <code>-j</code> options for compatibility with both systems. (For more information, see the mkisofs(8) man page.)
MMC-compliant recorder	Acronym for Multi Media Command, which means these recorders comply with a common command set. Programs that can write to one MMC-compliant recorder should be able to write to all other recorders.
Red Book CDDA	Acronym for Compact Disc Digital Audio, which is an industry standard method for storing digital audio on compact discs. Also known by the term "Red Book" format. The official industry specification calls for one or more audio files sampled in 16-bit stereo sound at a sampling rate of 44.1 kilohertz (kHz).

Commonly used terms when writing to CD media are listed in the following table.

Term	Description
blanking	The process of erasing data from the CD-RW media.

Term	Description
session	A complete track with lead-in and lead-out information.
track	A complete data or audio unit.

Writing CD and DVD Data and Audio CDs

The following procedures are described in this section:

- [“Restricting User Access to Removable Media” on page 200](#)
- [“How to Restrict User Access to Removable Media With Administrative Rights” on page 200](#)
- [“How to Identify a CD or DVD Writer” on page 201](#)
- [“How to Check the CD or DVD Media” on page 201](#)
- [“Creating a Data CD or DVD” on page 202](#)
- [“How to Create an ISO 9660 File System for a Data CD or DVD” on page 202](#)
- [“How to Create a Multi-Session Data CD” on page 203](#)
- [“Creating an Audio CD” on page 205](#)
- [“How to Create an Audio CD” on page 205](#)
- [“How to Extract an Audio Track on a CD” on page 206](#)
- [“How to Erase CD-RW Media” on page 208](#)

The process of writing to a CD or DVD cannot be interrupted and needs a constant stream of data. Consider using the `cdwr -s` option to simulate writing to the media to verify that the system can provide data at a sufficient rate for writing to the CD or DVD.

Write errors can be caused by one of the following problems:

- The media cannot handle the drive speed. For example, some media are only certified for 2x or 4x speeds.
- The system is running too many heavy processes that are starving the writing process.
- The image is on a remote system, and network congestion is causing delays in reading the image.
- The source drive is slower than the destination drive.

If any of these problems occur, you can lower the writing speed of the device by using the `cdwr -p` option.

For example, the following command shows how to simulate writing at 4x speed:

```
$ cdwr -iS -p 4 image.iso
```

Note - CD-R, CD-RW (not MRW formatted), DVD-R, and DVD-RW media support simulation mode (-S), but DVD-RAM, DVD+R, DVD+RW, and any MRW-formatted media and some others do not support simulation mode. The following message is displayed if simulation mode is not supported:

```
Media does not support simulated writing
```

For more information about media types, see [“CD/DVD Media Commonly Used Terms” on page 197](#).

For more information, see the [cdrw\(1\)](#) man page.

Restricting User Access to Removable Media

By default, all users can access removable media. However, you can restrict user access to removable media by setting up a role through administrative rights. Access to removable media is restricted by assigning the role to a limited set of users.

For a discussion of using roles, see [Chapter 3, “Assigning Rights in Oracle Solaris” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

▼ How to Restrict User Access to Removable Media With Administrative Rights

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Set up a role that includes the Device Management rights.

For more information, see [Chapter 3, “Assigning Rights in Oracle Solaris” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

```
# roleadd -m -d /export/home/muser -c "mediauser role" \  
-A solaris.device.cdrw -P All muser
```

3. Add users who need to use the cdrw command to the newly created role.

```
# usermod -R muser username
```

▼ How to Identify a CD or DVD Writer

1. Identify the CD or DVD writers on the system.

For example:

```
$ cdrw -l
Looking for CD devices...
Node          | Connected Device          | Device type
-----+-----+-----
cdrom0        | YAMAHA CRW8824S          | 1.0d | CD Reader/Writer
```

2. Identify a specific CD or DVD writer.

For example:

```
$ cdrw -a filename.wav -d cdrom2
```

3. Identify whether the media is blank or whether a table of contents exists on the media.

For example:

```
$ cdrw -M

Device : YAMAHA CRW8824S
Firmware : Rev. 1.00 (26/04/00)
Media is blank
%
```

▼ How to Check the CD or DVD Media

The `cdrw` command works with or without removable media services running. For more information about disabling or enabling removable media services, see [“How to Disable or Enable Removable Media Services” on page 250](#).

1. Insert a CD or DVD into the drive.

The CD or DVD can be any CD or DVD that the drive can read.

2. Check that the drive is connected properly by listing the drive.

```
$ cdrw -l
Looking for CD devices...
Node          | Connected Device          | Device type
-----+-----+-----
```

```
cdrom1          | YAMAHA   CRW8824S      1.0d | CD Reader/Writer
```

3. (Optional) If you do not see the drive in the list, select one of the following so that the system recognizes the drive.

- Add the drive without rebooting the system.

```
# devfsadm
```

- Restart removable media services

Creating a Data CD or DVD

Prepare the data first by using the `mkisofs` command to convert the file and file information into the High Sierra format used on CDs or DVDs.

▼ How to Create an ISO 9660 File System for a Data CD or DVD

1. **Insert a blank CD or DVD into the drive.**
2. **Create the ISO 9660 file system on the new CD or DVD.**

```
$ mkisofs -r /pathname > cd-file-system
```

`-r` Creates Rock Ridge information and resets file ownerships to zero.

`/pathname` Identifies the path name used to create the ISO 9660 file system.

`> cd-file-system` Identifies the name of the file system to be put on the CD or DVD.

3. **Copy the file system onto the CD or DVD.**

```
$ cdrw -i cd-file-system
```

The `-i cd-file-system` specifies the image file for creating a data CD or DVD.

Example 58 Creating an ISO 9660 File System for a Data CD or DVD

The following example shows how to create an ISO 9660 file system for a data CD or DVD.

```
$ mkisofs -r /home/dubs/dir > dubs_cd
Total extents actually written = 56
Total translation table size: 0
Total rockridge attributes bytes: 329
Total directory bytes: 0
Path table size(bytes): 10
Max brk space used 8000
56 extents written (0 Mb)
```

Then, copy the file system onto the CD.

```
$ cdrw -i dubs_cd
Initializing device...done.
Writing track 1...done.
Finalizing (Can take several minutes)...done.
```

▼ How to Create a Multi-Session Data CD

This procedure describes how to put more than one session on a CD. This procedure includes an example of copying the infoA and infoB directories onto the CD.

1. Create the file system for the first CD session.

```
$ mkisofs -o infoA -r -V my_infoA /data/infoA
Total translation table size: 0
Total rockridge attributes bytes: 24507
Total directory bytes: 34816
Path table size(bytes): 98
Max brk space used 2e000
8929 extents written (17 Mb)
```

-o infoA	Identifies the name of the ISO file system.
-r	Creates Rock Ridge information and resets file ownerships to zero.
-V my_infoA	Identifies a volume label to be used as the mount point by removable media services.
/data/infoA	Identifies the ISO image directory to create.

2. Copy the ISO file system for the first session onto the CD.

```
$ cdrw -i0 infoA
Initializing device...done.
```

```
Writing track 1...done.  
done.  
Finalizing (Can take several minutes)...done.
```

`-i infoA` Identifies the name of the image file to write to the CD.
`-0` Keeps the CD open for writing.

3. Reinsert the CD after it is ejected.
4. Identify the path name of the CD media to include in the next write session.

```
$ eject -l  
.  
.  
.  
cdrom0 -> /vol/dev/rdisk/c2t4d0/my_infoA
```

Note the `/vol/dev/...` path name.

5. Identify the next writeable address on the CD to write the next session.

```
% cdrw -M /cdrom  
Device : YAMAHA CRW8424S  
Firmware : Rev. 1.0d (06/10/99)
```

Track No.	Type	Start address
1	Audio	0
2	Audio	33057
3	Data	60887
4	Data	68087
5	Data	75287
Leadout	Data	84218

```
Last session start address: 75287  
Next writable address: 91118
```

Note the address in the Next writable address output so that you can provide this address when you write the next session.

6. Create the next ISO file system for the next CD session, and write it onto the CD.

```
$ mkisofs -o infoB -r -C 0,91118 -M /vol/dev/rdisk/c2t4d0/my_infoA  
/data/infoB  
Total translation table size: 0  
Total rockridge attributes bytes: 16602  
Total directory bytes: 22528
```

Path table size(bytes): 86
 Max brk space used 20000
 97196 extents written (189 Mb)

`-o infoB` Identifies the name of the ISO file system.

`-r` Creates Rock Ridge information and resets file ownerships to zero.

`-C 0,91118` Identifies the starting address of the first session and the next writable address.

`-M /vol/dev/rdisk/
c2t4d0/my_infoA` Specifies the path of the existing ISO image to be merged.

`/data/infoB` Identifies the ISO image directory to create.

Creating an Audio CD

You can use the `cdwr` command to create audio CDs from individual audio tracks or from `.au` and `.wav` files.

The supported audio formats are described in the following table.

Format	Description
<code>sun</code>	Oracle <code>.au</code> file with data in Red Book CDDA format
<code>wav</code>	RIFF (<code>.wav</code>) file with data in Red Book CDDA format
<code>cda</code>	<code>.cda</code> file with raw CD audio data, which is 16-bit PCM stereo at 44.1 kHz sample rate in little-endian byte order
<code>aur</code>	<code>.aur</code> files with raw CD data in big-endian byte order

If no audio format is specified, the `cdwr` command tries to determine the audio file format based on the file extension. The case of the characters in the extension is ignored.

▼ How to Create an Audio CD

This procedure describes how to copy audio files onto a CD.

1. **Insert a blank CD into the CD-RW drive.**

2. Change to the directory that contains the audio files.

```
$ cd /myaudiodir
```

3. Copy the audio files onto the CD.

```
$ cdrw -a track1.wav track2.wav track3.wav
```

The -a option creates an audio CD.

Example 59 Creating an Audio CD

The following example shows how to create an audio CD.

```
$ cdrw -a bark.wav chirp.au meow.wav
Initializing device...done.
Writing track 1...done.
done.
Writing track 2...done.
Writing track 3...done.
done.
Finalizing (Can take several minutes)...done.
```

The following example shows how to create a multi-session audio CD. The CD is ejected after the first session is written. You would need to reinsert the CD before the next writing session.

```
$ cdrw -a0 groucho.wav chico.au harpo.wav
Initializing device...done.
Writing track 1...done.
done.
Writing track 2...done.
Writing track 3...done.
done.
Finalizing (Can take several minutes)...done.
<Re-insert CD>
$ cdrw -a zeppo.au
Initializing device...done.
Writing track 1...done.
done.
Finalizing (Can take several minutes)...done.
```

▼ How to Extract an Audio Track on a CD

Use the following procedure to extract an audio track from a CD and copy the audio track to a new CD.

If you don't use the `cdrw -T` option to specify the audio file type, the `cdrw` command uses the filename extension to determine the audio file type. For example, the `cdrw` command detects that this file is a `.wav` file.

```
$ cdrw -x 1 testme.wav
```

1. Insert an audio CD into the CD-RW drive.

2. Extract an audio track.

```
$ cdrw -x -T audio-type 1 audio-file
```

`-x` Extracts audio data from an audio CD.

`T audio-type` Identifies the type of audio file to be extracted. Supported audio types are `sun`, `wav`, `cda`, or `aur`.

`audio-file` Identifies the audio track to be extracted.

3. Copy the track to a new CD.

```
$ cdrw -a audio-file
```

Example 60 Extracting and Creating Audio CDs

The following example shows how to extract the first track from an audio CD and name the file `song1.wav`.

```
$ cdrw -x -T wav 1 song1.wav
Extracting audio from track 1...done.
```

This example shows how to copy a track to an audio CD.

```
$ cdrw -a song1.wav
Initializing device...done.
Writing track 1...done.
Finalizing (Can take several minutes)...done.
```

▼ How to Copy a CD

This procedure describes how to extract all the tracks from an audio CD into a directory and then copy all of them onto a blank CD.

Note - By default, the `cdrw` command copies the CD into the `/tmp` directory. The copying might require up to 700 MB of free space. If there is insufficient space in the `/tmp` directory for copying the CD, use the `-m` option to specify an alternate directory.

1. Insert an audio CD into a CD-RW drive.

2. Create a directory for the audio files.

```
$ mkdir /music_dir
```

3. Extract the tracks from the audio CD.

```
$ cdrw -c -m music_dir
```

An `Extracting audio ...` message is display for each track.

The CD is ejected when all the tracks are extracted.

4. Insert a blank CD and press Return.

After the tracks are extracted, the audio CD is ejected. You are prompted to insert a blank CD.

Example 61 Copying a CD

This example shows how to copy one CD to another CD. You must have two CD-RW devices to do this task.

```
$ cdrw -c -s cdrom0 -d cdrom1
```

▼ How to Erase CD-RW Media

You have to erase existing CD-RW data before the CD can be rewritten.

● **Erase the entire media or just the last session on the CD by selecting one of the following:**

- Erase the last session only.

```
$ cdrw -d cdrom0 -b session
```

Erasing just the last session with the `-b session` option is faster than erasing the entire media with the `-b all` option. You can use the `-b session` option even if you used the `cdrw` command to create a data or audio CD in just one session.

- Erase the entire media.

```
$ cdrw -d cdrom0 -b all
```


Managing USB Devices

This chapter provides overview information and step-by-step instructions for using Universal Serial Bus (USB) devices in Oracle Solaris. The following topics are covered:

- “About USB Support in Oracle Solaris” on page 211
- “Managing USB Mass Storage Devices” on page 214
- “Hot-Plugging USB Devices With the `cfgadm` Command” on page 231
- “Using USB Audio Devices” on page 236

For general questions about USB, go to <https://www.usb.org/> and search their documentation library.

For general information about dynamic reconfiguration and hot-plugging, see [Chapter 2](#), “Dynamically Configuring Devices”.

About USB Support in Oracle Solaris

Oracle Solaris supports all USB 3.0 devices that use the USB 3.0 `xhci` host controller driver, with the exception of audio devices. Backward compatibility with previous USB versions enables you to use the same hardware and software components for USB 2.0, 1.1, and 1.0 devices on USB 3.0 ports. However, for audio devices, only USB 2.0, 1.1, and 1.0 are supported.

A single XHCI host controller supports all speeds of the USB devices. If you are using USB 2.0 ports for devices, different host controller interface drivers are dynamically assigned depending on whether those devices support USB 2.0.

Note - For devices that are not supported by a USB driver, refer to the USB library documentation in `/usr/share/doc/libusb/libusb.txt`.

For better performance, always connect USB 3.0 and USB 2.0 devices to corresponding USB 3.0 and USB 2.0 ports. A USB 3.0 or USB 2.0 port can be on any of the following components:

- A USB PCI card
- A USB hub that is connected to a USB port
- A SPARC or x86 computer motherboard

Note - A USB 2.0 PCI card might be needed for older SPARC platforms.

References for USB Information in Oracle Solaris

The following man pages provide information about USB versions:

USB 3.0	xhci(4D)
USB 2.0	ehci(4D) ; usba(4D)
USB 1.1	ohci(4D)

The following man pages provide information about specific USB devices:

Generic USB drivers	ugen(4D)
Keyboard and mouse devices	hid(4D)
Hubs	hubd(4D)
Serial devices	usbser_edge(4D) ; usbspr1(4D) ; usbsksp(4D)
Storage devices	scsa2usb(4D)
Device management	libusb(3lib)

For information about specifications of different USB versions, go to <https://www.usb.org/>.

USB Device Features and Compatibility Issues

To identify the speed of your USB device, check the `/var/adm/messages` file for messages similar to the following:

```
Dec 13 17:05:57 mysystem usba: [ID 912658 kern.info] USB 2.0 device
(usb50d,249) operating at hi speed (USB 2.x) on USB 2.0 external hub:
storage@4, scsa2usb0 at bus address 4
```

Except where indicated, Oracle Solaris supports USB devices on both SPARC and x86 based systems. Additional storage devices might work by modifying the `scsa2usb.conf` file. For more information, see the [scsa2usb\(4D\)](#) man page.

The following sections provide additional information about specific USB devices.

Bus-Powered Devices

USB hubs are not self-powered. They supply power to connected devices by deriving it from the USB bus to which they are connected. Consequently, and also because of power management, power to these downstream devices is limited. Therefore, avoid overloading these hubs. Note specifically the following limitations:

- You cannot cascade two bus-powered hubs.
- Each bus-powered hub is limited to a maximum of 100 mA only for each port.
- You can connect only self-powered or low bus-powered devices, not high bus-powered devices, to a bus-powered hub.
- Some hubs or devices can report a false power source. With such hubs, the connection might be unpredictable.

USB Keyboards and Mouse Devices

On SPARC based systems, do not remove the keyboard and mouse during a system reboot or at the `ok` prompt. During the boot process, the OpenBoot PROM (OBP) limits keyboard and mouse devices to the motherboard root hub ports only. You can move the keyboard and mouse to another hub at any time after a system reboot. These devices become fully functional after you plug them to their ports.

On SPARC based systems, the power key behaves differently between a USB keyboard and a type 5 keyboard. On a USB keyboard, the SUSPEND/SHUTDOWN key suspends or shuts down the system. However, that key cannot power up the system.

For information about multiple keyboard and mouse device support, see the [virtualkm\(4D\)](#) man page.

USB Hubs and Host Controller

The USB host controller has an embedded hub called the *root hub* whose ports are visible on the back panel of the system.

When using USB hubs, avoid the following:

- Cascading hubs beyond four levels on either SPARC based systems or x86 based systems. On SPARC systems, the OpenBoot PROM cannot reliably probe beyond four levels of devices.
- Cascading bus-powered hubs. A bus-powered hub does not have its own power supply.
- Connecting a device that requires a large amount of power to a bus-powered hub might drain the hub of power for other devices. Bus-powered hubs might deny connection to these devices.

Note - A USB 3.0 host controller supports control, bulk, and interrupt transfer types. However, unlike previous USB versions, it does not support isochronous transfer type.

SPARC: USB Power Management

Suspending and resuming USB device services are fully supported on SPARC systems. However, do not suspend a device that is busy. Likewise, never remove a device when the system is powered off under a suspend shutdown.

When power management is enabled on the system, the USB framework manages power on all devices. For example, the hub driver suspends the port to which the device is connected.

Devices that support *remote wake up* can notify the system to restore power to the path of the device so that the device can be used. The host system can also restore power to the device if an application sends an I/O to the device.

Power management is implemented on all devices that support remote wake-up capability. On USB printers, power management functions only between two print jobs. On devices that use the generic USB driver (UGEN), power management runs only when the devices are closed.

Managing USB Mass Storage Devices

In Oracle Solaris, USB mass storage devices are hot-pluggable and share the same features as most removable media devices.

A hot-pluggable device is automatically mounted and immediately available in the `/media` directory. Users can readily access the device. If no automatic mount occurs, you can mount devices manually with the `mount` command. The following example mounts a disk with the FAT file system:

```
mount -F pcfs /dev/dsk/c2t0d0s0:c /mnt
```

USB storage devices are power managed, except those that support LOG SENSE pages. Devices with LOG SENSE pages are typically SCSI drives connected through a USB-to-SCSI bridge device.

To configure or manage USB storage devices, use the following commands:

- The `rmformat` command creates slices or displays all USB devices with their media inserted.
- The `fdisk` command partitions a USB device.



Caution - Do not use the `format` command or the `rmformat -F` command to physically format a USB drive.

Applications might work differently with USB mass storage devices. For example, some earlier applications might make incorrect assumptions about the size of the media because previously, only smaller devices were removable.

To revert to a previous Oracle Solaris behavior that treated USB mass storage devices as removable media devices, update the `/etc/driver/drv/scsa2usb.conf` file. For more information, see the [scsa2usb\(4D\)](#) man page.

Hot-Plugging USB Mass Storage Devices

Hot-plugging a device means adding or removing the device without shutting down the operating system or rebooting the system. These devices are also automatically configured or unconfigured without user intervention.

All USB devices are hot-pluggable. However, non-removable USB storage devices are identified as hot-pluggable devices only at the driver level. When these devices are connected or disconnected, the changes caused by automatic configuration or unconfiguration occur at the kernel level and do not affect the use of the devices.

The removable media services manage the mounting of removable media, including hot-pluggable devices. To determine whether the service is running, type the following command:

```
# svcs hal dbus rmvolmgr
STATE          STIME    FMRI
online         May_03   svc:/system/dbus:default
online         May_03   svc:/system/hal:default
online         May_03   svc:/system/filesystem/rmvolmgr:default
```

With hot-plugged devices, the file system can be mounted from the device if the device is valid and recognized. While file system mounts occur automatically, you can mount the file system manually if necessary.

Before disconnecting a hot-pluggable device, issue an `eject` command first. Use the `eject -l` command to determine the name of the device. Failure to eject before disconnecting the device might damage the file system of the device, even though the device itself is released and the port becomes available for use.

When you connect a USB device, the device is immediately added to the device hierarchy of the system and is included in the output of the `prtconf` command.

If you disconnect a device, the device is removed from the device hierarchy of the system only if no application is using the device. If an application is using a device that becomes disconnected, the device node remains. However, the driver controlling the device stops all activity on the device. Any new I/O activity issued to this device returns an error. The system then prompts you to connect the original device. If the device is no longer available, stop the application. After a few seconds, the port is released.

Note - Removing an active or open device might damage data integrity. Always close the device before removing it. However, you can move the keyboard and mouse even while these devices are active.

Displaying USB Information

You can access information about removable media with or without using removable media services. For information about accessing information on removable media with GNOME's File Manager, see the GNOME desktop documentation.

After being formatted, the USB device is usually mounted under the `/media/label` directory.

The device nodes are created under the `/dev/rdisk` directory for character devices and under the `/dev/dsk` directory for block devices. Device links are created when the devices are hot-plugged. For more information, see the [scsa2usb\(4D\)](#) man page.

For more information about mounting and unmounting USB devices, see [“How to Mount or Unmount a USB Mass Storage Device”](#) on page 227.

The following examples show how to display USB information.

- Using the `prtconf` command:

In this example, the output is truncated to display only USB device information.

```
$ prtconf
```

```

usb, instance #0
hub, instance #2
device, instance #8
interface (driver not attached)
printer (driver not attached)
mouse, instance #14
device, instance #9
keyboard, instance #15
mouse, instance #16
storage, instance #7
disk (driver not attached)
communications, instance #10
modem (driver not attached)
data (driver not attached)
storage, instance #0
disk (driver not attached)
storage, instance #1
disk (driver not attached)

```

- Using the `rmformat` command

```

$ rmformat
Looking for devices...
1. Logical Node: /dev/rdisk/c3t0d0p0
Physical Node: /pci@0,0/pci108e,534a@2,1/storage@3/disk@0,0
Connected Device: SanDisk Cruzer Micro 0.3
Device Type: Removable
Bus: USB
Size: 245.0 MB
Label: <None>
Access permissions: Medium is not write protected.

```

Creating File Systems on USB Storage Devices

The file systems are automatically mounted on hot-pluggable devices. On certain removable devices, you might need to create the file system after the devices are connected. This section provides some examples of how to create the file systems.

Before you create the file system, ensure that the device is unmounted. To create a file system, use the following command syntax:

```
# mkfs -F FS-type -o FS-type-specific-options raw-device-file
```

FS-type Type of file system you want to create.

<i>FS-type-specific-options</i>	Options that are specific to the type of file system you are creating such as size for FAT file systems.
<i>raw-device-file</i>	Disk partition on which to write the file system.

Note - You must format USB storage devices first before creating file systems on them. All other mass storage devices require only a file system before you can use them.

The following example shows how to create a PCFS file system on a 100-MB USB memory stick on a SPARC system:

```
# mkfs -F pcfs /dev/rdisk/c5t0d0s2:c
```

The following example shows how to create a PCFS file system on a 100-MB USB memory stick on an x86 system:

```
# mkfs -F pcfs /dev/rdisk/c5t0d0p0:c
```

The following example shows how to create a legacy UFS file system.

```
# newfs /dev/rdisk/c0t0d0s6
```

▼ How to Add a USB Mass Storage Device

1. **Connect the USB mass storage device.**
2. **Verify that the USB device has been added.**

```
$ rmformat
```

The following example shows the output of the command after you connect a storage device.

```
$ rmformat
Looking for devices...
1. Logical Node: /dev/rdisk/c3t0d0p0
Physical Node: /pci@0,0/pci108e,534a@2,1/storage@3/disk@0,0
Connected Device: SanDisk Cruzer Micro 0.3
Device Type: Removable
Bus: USB
Size: 245.0 MB
Label: <None>
Access permissions: Medium is not write protected.
```

3. **Verify that the device is automatically mounted under the `/media` directory.**
Use one of the following commands:

- `ls /media/NONAME`

For example:

```
$ ls /media/NONAME  
aa bb
```

- `rmmount -l`

For example:

```
$ rmmount -l  
/dev/dsk/c3t0d0p0:1 rmdisk0,NONAME,/media/NONAME
```

▼ How to Remove a USB Mass Storage Device

1. **Stop any active applications that are using the device.**

2. **Unmount the device.**

Use one of the following commands:

- As a regular user: `rmumount name`

For example:

```
$ rmumount NONAME
```

- As an administrator: `umount name`

For example:

```
# umount /media/NONAME
```

3. **Remove the device.**

▼ How to Create a File System on a USB Mass Storage Device

Devices typically have default slices. If the default slices are not acceptable refer to the following sections to create the slices:

- [“How to Modify Partitions and Create a PCFS File System on a USB Mass Storage Device” on page 221](#)

- [“How to Create a Solaris Partition and Modify the Slices on a USB Mass Storage Device” on page 225](#)

1. **Become an administrator.**
2. **Add the USB device to your system. For information about hot-plugging USB devices, see:**
 - [“Hot-Plugging USB Mass Storage Devices” on page 215](#)
 - [“Hot-Plugging USB Devices With the `cfgadm` Command” on page 231](#)
3. **(Optional) Identify the USB device by using the `rmformat` command.**

In the following example, the device is `c2t0d0p0`.

```
# rmformat
Looking for devices...
1. Logical Node: /dev/rdisk/c2t0d0p0
Physical Node: /pci@0,0/pci108e,534a@2,1/hub@7/floppy@1/disk@0,0
Connected Device: MITSUMI USB FDD 1039
Device Type: Floppy drive
Bus: USB
Size: 1.4 MB
Label: <None>
Access permissions: Medium is not write protected.
```

4. **Perform this step only if you need to format a USB memory stick. Otherwise, skip to the next step.**
 - a. **Insert the USB memory stick into the drive.**
 - b. **Format the USB memory stick, if necessary.**

```
# rmformat -F long raw-device-file
```

where *raw-device-file* is the storage partition in which to write the file system.



Caution - Use the `rmformat -F` command **only** on USB memory sticks.

5. **Determine the file system type to create, if necessary.**
6. **Unmount the device, if necessary.**

For more information about unmounting a USB device, see [“How to Mount or Unmount a USB Mass Storage Device” on page 227](#).

7. Create the file system.

Select one of the following:

- Create a ZFS pool and file system on a USB stick if you need to transfer data to another system.

```
# zpool create device temp-pool
# zfs create temp-pool/data
```

The following example creates a ZFS pool for the device `c5t0d0` and then creates the file system on the pool.

```
# zpool create c5t0d0 usbpool
# zfs create usbpool/data
```

- Create a PCFS file system.
For information and examples, see [“Creating File Systems on USB Storage Devices” on page 217](#)
- Create a legacy UFS file system.
For information and examples, see [“Creating File Systems on USB Storage Devices” on page 217](#)

▼ How to Modify Partitions and Create a PCFS File System on a USB Mass Storage Device

The following steps describe how to delete an existing partition, create a new partition, and then create a PCFS file system on the USB device. Make sure you backup any data before you perform this task.

1. **Become an administrator.**
2. **Modify the partitions as follows:**
 - a. **Start the `fdisk` utility.**

```
# fdisk device
```
 - b. **On the interactive interface that is displayed, choose the appropriate options for the following actions as prompted.**
 - Delete the partition.

- Specify the partition number to delete.
 - Create the partition.
 - Select the partition type to create.
 - Specify the percentage of disk space to use for the partition.
 - Specify whether the new partition will be active or inactive.
 - Choose to update the disk configuration and exit.
3. **Unmount the device, if necessary.**
For more information about unmounting a USB device, see [“How to Mount or Unmount a USB Mass Storage Device” on page 227](#).
 4. **Create the PCFS file system on this partition.**

```
# mkfs -F FS-type -o FS-type-specific-option raw-device-file
```

Example 62 Modifying the Partitions of a USB Storage Device

In the following example, the disk configuration of `c3t0d0p0` is modified, starting with the creation of a new partition.

```
# fdisk /dev/rdisk/c3t0d0p0

Total disk size is 29 cylinders
Cylinder size is 2048 (512 byte) blocks

Cylinders
Partition  Status  Type           Start  End  Length  %
=====  =====  =====
1         Active  Solaris2      1     28    28     97

SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)
Enter Selection: 3    Partition will be deleted.

Total disk size is 29 cylinders
Cylinder size is 2048 (512 byte) blocks

Cylinders
Partition  Status  Type           Start  End  Length  %
=====  =====  =====
```

```
1      Active   Solaris2      1  28    28    97
```

SELECT ONE OF THE FOLLOWING:

1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)

Specify the partition number to delete (or enter 0 to exit): **1** *Partition number to delete.*

Partition deleted. *Deletion is completed.*

Total disk size is 29 cylinders
 Cylinder size is 2048 (512 byte) blocks

```
Cylinders
Partition  Status   Type           Start  End    Length  %
=====  =====  =====

```

WARNING: no partitions are defined!

SELECT ONE OF THE FOLLOWING:

1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)

Enter Selection: **1** *Partition will be created.*

Total disk size is 29 cylinders
 Cylinder size is 2048 (512 byte) blocks

```
Cylinders
Partition  Status   Type           Start  End    Length  %
=====  =====  =====

```

WARNING: no partitions are defined!

SELECT ONE OF THE FOLLOWING:

1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)

6. Cancel (exit without updating disk configuration)
Select the partition type to create:
1=SOLARIS2 2=UNIX 3=PCIXOS 4=Other
5=DOS12 6=DOS16 7=DOSEXT 8=DOSBIG
9=DOS16LBA A=x86 Boot B=Diagnostic C=FAT32
D=FAT32LBA E=DOSEXTLBA F=EFI 0=Exit? **c** *Partition type is selected.*

Total disk size is 29 cylinders
Cylinder size is 2048 (512 byte) blocks

Cylinders	Partition	Status	Type	Start	End	Length	%
=====	=====	=====	=====	=====	=====	=====	=====

WARNING: no partitions are defined!

SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)
Select the partition type to create:
Specify the percentage of disk to use for this partition (or type "c" to specify the size in cylinders). **100** *Percentage of disk space is specified.*

Total disk size is 29 cylinders
Cylinder size is 2048 (512 byte) blocks

Cylinders	Partition	Status	Type	Start	End	Length	%
=====	=====	=====	=====	=====	=====	=====	=====

WARNING: no partitions are defined!

SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)
Select the partition type to create:
Should this become the active partition? If yes, it will be activated each time the computer is reset or turned on.

Please type "y" or "n". **n** *Inactive partition is selected.*

Total disk size is 29 cylinders
 Cylinder size is 2048 (512 byte) blocks

Partition	Status	Type	Start	End	Length	%
1		Win95 FAT32	1	28	28	97

SELECT ONE OF THE FOLLOWING:

1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Exit (update disk configuration and exit)
6. Cancel (exit without updating disk configuration)

Enter Selection: **5** *Disk configuration will be updated.*

```
# mkfs -F pcfs -o fat=32 /dev/rdisk/c3t0d0p0:c
```

Construct a new FAT file system on /dev/rdisk/c3t0d0p0:c: (y/n)? **y** *File system is created.*

▼ How to Create a Solaris Partition and Modify the Slices on a USB Mass Storage Device

The following steps illustrate how to create a Solaris partition and modify the slices.

Make sure you back up any data before you perform this task.

1. **Become an administrator.**
2. **(Optional) Display the partition information on the system.**

```
# fdisk device
```

3. **Display the current slices.**

```
# prtvtoc device
```

4. **Create a text file with the slice information.**

Make sure each slice starts on a cylinder boundary. For example, slice 1 starts at 822280000 bytes, which is the cylinder size in bytes multiplied by 1000.

For more information, see the `-s` option description in the [rmformat\(1\)](#) man page.

5. Create the slices by referring to the slice file created in the previous step.

```
# rmformat -s slice-file device
```

6. View the new slice information.

```
# prtvtoc device
```

Example 63 Creating Slices on a USB Device

In the following example, slices are created on the device `c5t0d0s2`. The slice file `myslice` has been created with the following content:

```
sllices: 0 = 0, 5GB, "wm", "home" :
1 = 8225280000, 6GB :
2 = 0, 44GB, "wm", "backup" :
6 = 16450560000, 15GB
```

The file will be used when creating the new slices.

```
# fdisk /dev/rdisk/c5t0d0s2
```

No fdisk table exists. The default partition for the disk is:

```
a 100% "SOLARIS System" partition
```

Type "y" to accept the default partition, otherwise type "n" to edit the partition table.

```
y The current partition is accepted and will not be modified.
```

```
# prtvtoc /dev/rdisk/c5t0d0s2
```

```
* /dev/rdisk/c5t0d0s2 partition map
```

```
*
```

```
* Dimensions:
```

```
* 512 bytes/sector
```

```
* 63 sectors/track
```

```
* 255 tracks/cylinder
```

```
* 16065 sectors/cylinder
```

```
* 5836 cylinders
```

```
* 5836 accessible cylinders
```

```
*
```

```
* Flags:
```

```
* 1: unmountable
```

```
* 10: read-only
```

```
*
```

```
* Partition Tag Flags First Sector Last Sector Mount Directory
```

```

0      0      00          0 93755340 93755339
2      0      00          0 93755340 93755339

# rmformat -s mysllice /dev/rdisk/c5t0d0s2

# prtvtoc /dev/rdisk/c5t0d0s2
* /dev/rdisk/c5t0d0s2 partition map
*
* Dimensions:
*   512 bytes/sector
*   63 sectors/track
*   255 tracks/cylinder
* 16065 sectors/cylinder
*   5836 cylinders
*   5836 accessible cylinders
*
* Flags:
*   1: unmountable
*  10: read-only
*
* Unallocated space:
*   First Sector      Last
*   Sector   Count   Sector
* 10485760  5579240 16064999
* 28647912  3482088 32129999
* 63587280 30168060 93755339
*
*
* Partition Tag  Flags   First Sector   Sector   Last
* Partition Tag  Flags   Sector   Count   Sector   Mount Directory
0      8      00          0 10485760 10485759
1      3      01 16065000 12582912 28647911
2      5      00          0 92274688 92274687
6      4      00 32130000 31457280 63587279

```

▼ How to Mount or Unmount a USB Mass Storage Device

The following steps illustrate how to mount and unmount a USB mass storage device.

1. **Become an administrator.**
2. **(Optional) Identify the device.**

```
$ rmformat
```

The following example identifies a physical storage device as `c2t0d0p0`.

```
$ rmformat
Looking for devices...
1. Logical Node: /dev/rdisk/c3t0d0p0
Physical Node: /pci@0,0/pci108e,534a@2,1/storage@3/disk@0,0
Connected Device: SanDisk  Cruzer Micro    0.3
Device Type: Removable
Bus: USB
Size: 245.0 MB
Label: <None>
Access permissions: Medium is not write protected.
```

3. Select one of the following to mount or unmount a USB mass storage device:

- Mount a USB mass storage device as a console user.

You can use the `rmmount` command with device nicknames, mount points, or device paths, similar to the following:

```
$ rmmount rmdisk0
$ rmmount NONAME
$ rmmount /dev/dsk/c3t0d0p0:1
```

The following example mounts `c2t0d0p0` whose mount point is `NONAME`.

```
$ rmmount NONAME
NONAME /dev/dsk/c2t0d0p0 mounted
$ ls /media/NONAME
AA.TXT
```

- Unmount a USB mass storage device as a console user.

The following example unmounts `c2t0d0p0` whose mount point is `NONAME`.

```
$ rmmount NONAME
NONAME /dev/dsk/c2t0d0p0 unmounted
```

- Mount a USB mass storage device as superuser.

The following example mounts `c1t0d0s2` with a UFS file system:

```
$ mount /dev/dsk/c1t0d0s2 /mnt
```

The following example mounts `c3t0d0s2` with a PCFS file system on a SPARC system:

```
$ mount -F pcfs /dev/dsk/c3t0d0s2:c /mnt
```

The following example mounts `c3t0d0p0` with a PCFS file system on an x86 system:

```
$ mount -F pcfs /dev/dsk/c3t0d0p0:c /mnt
```

The following example mounts `c1t0d0s2` with a read-only HSFS file system:

```
$ mount -F hsfs -o ro /dev/dsk/c1t0d0s2 /mnt
```

- Unmount a USB mass storage device as superuser.

The following example unmounts a storage device.

```
$ fuser -c -u /mnt
$ umount /mnt
```

4. Eject the device.

This step is optional for DVD, CD, or memory stick.

```
$ eject /dev/rdisk/c1t0d0s2
```

The following example ejects `c1t0d0s2`.

Troubleshooting Tips for USB Mass Storage Devices

Check the `/var/adm/messages` file for failures to enumerate the device. In cases of failures that involve hubs, insert the USB hub or remove a hub and connect it directly to a root USB hub.

- If you have problems accessing a device that was connected while the system is running, issue following command:

```
# devfsadm
```

- Do not move devices around if the system has been powered down by a suspend operation. For more information, see [“USB Power Management” on page 214](#).
- If a device has been removed while in use by applications and is no longer available, stop the applications. Use the `prtconf` command to see whether the device node has been removed.

Disabling Specific USB Drivers

You can disable specific types of USB devices by disabling their client driver. For example, USB printers can be disabled by disabling the `usbprn` driver that directs them. Disabling `usbprn` does not affect other kinds of devices, such as USB storage devices.

The following list identifies some USB device types and their corresponding drivers:

Audio	usb_ac and usb_as
HID	hid (usually keyboard and mouse)
Storage	scsa2usb
Printer	usbprn
Serial	usbser_edge

If you disable a driver for a USB device that is still connected to the system, a warning message similar to the following is displayed:

```
usb10: WARNING: usba: no driver found for device name
```

▼ How to Disable Specific USB Drivers

1. **Become an administrator.**
2. **Use the `pfedit` command to edit the `/etc/system` file.**

```
# pfedit /etc/system
```

3. **Add an `exclude` line that refers to the driver alias entry.**

The following example excludes the USB printer driver.

```
exclude: usbprn
```

4. **Reboot the system.**

```
# init 6
```

▼ How to Remove Unused USB Device Links

Use this procedure if a USB device is removed while the system is powered off. Removing the USB device while the system is powered off can leave device links for devices that do not exist.

1. **Become an administrator.**

2. **Close all applications that might be accessing the device.**
3. **Remove the unused links for a specific USB class.**

Choose one of the following commands:

- `devfsadm -C -c USB-class`

The following example removes the unused links for the audio class of devices.

```
# devfsadm -C -c audio
```

- `devfsadm -C`

The command removes all dangling links.

Hot-Plugging USB Devices With the `cfgadm` Command

You can add and remove a USB device from a running system without using the `cfgadm` command. However, the `cfgadm` command enables you to perform *logical* hot-plug operations on the USB device. In logical hot-plug operations, you do not have to physically handle the device. Thus, you can remotely disable or reset a non functioning USB device without having to remove the device itself. The `cfgadm` command also enables you to display the USB device tree, including manufacturer and product information.

The `cfgadm` command works on USB devices in the same manner that it does on other hot-pluggable devices. For more conceptual and overview information about how the command works, see the relevant sections in [Chapter 2, “Dynamically Configuring Devices”](#).

The following `cfgadm` commands apply to all devices including USB devices. See detailed information in [Chapter 2, “Dynamically Configuring Devices”](#):

```
cfgadm -l[a]           Displays information about devices.
```

```
cfgadm -c             Configures or unconfigures a device.
configure
device; cfgadm -c
unconfigure
device
```

```
cfgadm -c             Connects or disconnects a device.
connect device;
cfgadm -c
disconnect device
```

`cfgadm -x usb-option device` Perform logical operations on a USB device. The command is specific to USB devices only.

Note - The `prtconf` command can also display configuration information of all devices including USB devices.

The following examples show the use of the `cfgadm` command to perform hot-plug operations on USB devices. The sample output displays only information relevant to USB devices. The actual command output depends on the devices on your system.

EXAMPLE 64 Displaying USB Bus Information

```
$ cfgadm
Ap_Id                Type      Receptacle  Occupant  Condition
usb0/4.5             usb-hub   connected   configured ok
usb0/4.5.1           usb-device connected   configured ok
usb0/4.5.2           usb-printer connected   configured ok
usb0/4.5.3           usb-mouse connected   configured ok
usb0/4.5.4           usb-device connected   configured ok
usb0/4.5.5           usb-storage connected   configured ok
usb0/4.5.6           usb-communi connected   configured ok
usb0/4.5.7           unknown   empty       unconfigured ok
```

Using `usb0/4.5.1` as an example, you obtain the following information from the output:

- `usb0` refers to the first USB controller.
- The 3 dot-separated numbers after the device name indicate that in addition to the root hub, the system has 2 external hubs.
 - The first number refers to port 4 of the controller's root hub.
 - The second number refers to port 5 of the first-level external hub.
 - The third number refers to port 1 of the second-level external hub.

Note that as a useful practice, you should display information about the system devices before and after the actual hot-plugging step. The information helps you in the following ways:

- You can properly identify the bus or device to dynamically reconfigure.
- You can verify from the state of the bus or device that the reconfiguration completed successfully.

You can also customize the specific information that you want about a USB device. The following example provides full information about the devices.

```
$ cfgadm -l -s "cols=ap_id:info"
```

```

Ap_Id      Information
usb0/4.5.1 Mfg: Inside Out Networks Product: Edgeport/421 NConfigs: 1
           Config: 0 : ...
usb0/4.5.2 Mfg: <undef> Product: <undef> NConfigs: 1 Config: 0 ...
usb0/4.5.3 Mfg: Mitsumi Product: Apple USB Mouse NConfigs: 1
           Config: 0 ...
usb0/4.5.4 Mfg: NMB Product: NMB USB KB/PS2 M NConfigs: 1 Config: 0
usb0/4.5.5 Mfg: Hagiwara Sys-Com Product: SmartMedia R/W NConfigs: 1
           Config: 0 : ...
usb0/4.5.6 Mfg: 3Com Inc. Product: U.S.Robotics 56000 Voice USB Modem
           NConfigs: 2 ...
usb0/4.5.7

```

EXAMPLE 65 Unconfiguring a USB Device

You can unconfigure a USB device and leave it physically connected to the system. The device continues to be included in a `prtconf` command output. However, no driver will attach to the device.

```
# cfgadm -c unconfigure usb0/4.7
```

```
Unconfigure the device: /devices/pci@8,700000/usb@5,3/hub@4:4.7
```

```
This operation will suspend activity on the USB device
```

```
Continue (yes/no)? y
```

```
# cfgadm -l
```

Ap_Id	Type	Receptacle	Occupant	Condition	
usb0/4.5	usb-hub	connected	configured	ok	
usb0/4.5.1	usb-device	connected	configured	ok	
usb0/4.5.2	usb-printer	connected	configured	ok	
usb0/4.5.3	usb-mouse	connected	configured	ok	
usb0/4.5.4	usb-device	connected	configured	ok	
usb0/4.5.5	usb-storage	connected	configured	ok	
usb0/4.5.6	usb-communi	connected	configured	ok	
usb0/4.5.7	unknown	empty	unconfigured	ok	
usb0/4.6	usb-storage	connected	configured	ok	
usb0/4.7	usb-storage	connected	unconfigured	ok	<i>Device is unconfigured.</i>

EXAMPLE 66 Configuring a USB Device

```
# cfgadm -c configure usb0/4.7
```

```
# cfgadm usb0/4.7
```

Ap_Id	Type	Receptacle	Occupant	Condition
usb0/4.7	usb-storage	connected	configured	ok

EXAMPLE 67 Logically Disconnecting a USB Device

In this example, the USB device remains physically connected to the system. However, it becomes unusable after being logically disconnected. The `prtconf` command output will not include this device in the output.

```
# cfgadm -c disconnect -y usb0/4.7
# cfgadm usb0/4.7
Ap_Id                Type      Receptacle  Occupant  Condition
usb0/4.7             unknown  disconnected  unconfigured  ok    The device is
disconnected and becomes unavailable.
```

EXAMPLE 68 Logically Connecting a USB Device

You can connect a USB device remotely without physical access to the device. However, the device must be physically connected to the system for a logical connection to succeed.

```
# cfgadm -c configure usb0/4.7
# cfgadm usb0/4.7
Ap_Id                Type      Receptacle  Occupant  Condition
usb0/4.7             usb-storage  connected  configured  ok    The device is connected
and becomes available.
```

EXAMPLE 69 Logically Disconnecting a USB Device Subtree

In this example, the entire hierarchy of devices below the hub is removed.

```
# cfgadm -c disconnect -y usb0/4
# cfgadm usb0/4
Ap_Id                Type      Receptacle  Occupant  Condition
usb0/4              unknown  disconnected  unconfigured  ok    All devices under port 4 of
the hub are disconnected.
```

EXAMPLE 70 Resetting a USB Device

Resetting a device removes and then recreates the device. You can reset a device that behaves erratically. This example assumes that the device is not in use. Resetting fails if any application is using the device.

```
# cfgadm -x usb_reset -y usb0/4.7
# cfgadm usb0/4.7
Ap_Id                Type      Receptacle  Occupant  Condition
usb0/4.7             usb-storage  connected  configured  ok
```

About Multi-Configurations of a USB Device

A USB device configuration defines how a device presents itself to the operating system. USB device configuration differs from system device configurations that use the `cfgadm` command and which are discussed in other sections in this book.

Some USB devices support multiple configurations. However, only one configuration can be active at a time. You can identify devices with multi-configurations by using the `cfgadm -lv` command. From the command output, two parameters provide multi-configuration information:

- `Nconfigs` indicates the number of configurations for the device.
- `Config` indicates the configuration that is currently active and is therefore the default configuration.

Changes to the default configuration persist across reboots, hot-removes, and the reconfiguration of the device, provided that the device is reconnected to the same port.

▼ How to Change the Default Configuration of a Multi-Configuration USB Device

1. **Become an administrator.**
2. **Make sure that the device is not in use.**
3. **(Optional) Display the current USB device configuration.**

```
# cfgadm -lv [device]
```

You can specify the device if you already know the `Ap_Id` whose default configuration you are changing.

4. **Change the default USB configuration.**

Ensure that you also confirm the action at the prompt.

```
# cfgadm -x usb_config -o config=config-number device
```

The following example changes the configuration of `usb0/4` from 1 to 2.

```
# cfgadm -x usb_config -o config=2 usb0/4
Setting the device: /devices/pci@1f,0/usb@c,3:4
to USB configuration 2
```

```
This operation will suspend activity on the USB device
Continue (yes/no)? yes
```

5. Verify that the device changed.

```
# cfgadm -lv device
```

The following example shows the changes for `usb0/4` after the previous step.

```
# cfgadm -lv usb0/4
Ap_Id Receptacle Occupant Condition Information
When Type Busy Phys_Id
usb0/4 connected unconfigured ok Mfg: Sun
2000 Product: USB-B0B0 aka Robotech
With 6 EPPS High Clk Mode NConfigs: 7 Config: 2 : Default configuration is now 2.
EVAL Board Setup unavailable
usb-device n /devices/pci@1f,0/usb@c,3:4
```

Using USB Audio Devices

For audio devices in Oracle Solaris, only USB 2.0, 1.1, and 1.0 are supported, not USB 3.0. Additionally, the support is for those devices that are play-only, record-only, or record and play.

Oracle Solaris USB audio support is implemented by a pair of drivers:

- Audio control driver (`usb_ac`) – provides the controlling interface to user applications. For more information, see the [usb_ac\(4D\)](#) man page.
- Audio streaming driver (`usb_as`) – processes audio data messages during play and record. It sets sample frequency and precision, and encodes requests from the `usb_ac` driver. For more information, see the [usb_as\(4D\)](#) man page.

Some audio devices can set volume under software control. A STREAMS module, `usb_ah`, is pushed on top of the human interface device (HID) driver for managing this function. For more information, see the [usb_ah\(4M\)](#) man page.

The primary audio device is `/dev/audio`. To verify that `/dev/audio` is pointing to USB audio, use the `mixerctl` command. For example:

```
%%$ mixerctl
Device /dev/audioctl:
Name = USB Audio
Version = 1.0
Config = external
```

Audio mixer for `/dev/audiocctl` is enabled

You access connected USB audio devices with the `audioplay` and `audiorecord` command through the `/dev/sound/N` device links.

Note that the `/dev/audio` and `/dev/sound/N` devices can refer to speakers, microphones, or combination devices. If you refer to the incorrect device type, the command fails. For example, the `audioplay` command fails if you try to use it with a microphone.

You can select a specific default audio device for most Oracle Solaris audio applications, such as `audioplay` and `audiorecord`, by setting the `AUDIODEV` shell variable or by specifying the `-d` option for these commands. However, setting `AUDIODEV` does not work for third-party applications that have `/dev/audio` hardcoded as the audio file.

A USB plugged-in audio device automatically becomes the primary audio device, `/dev/audio`, provided that `/dev/audio` is not in use. It remains the primary audio device even after the system is rebooted. If additional USB audio devices are plugged in, the last one becomes the primary audio device.

For instructions on switching `/dev/audio` between on-board audio and USB, refer to [“Problem With Reverting to On-Board Audio Device” on page 239](#), and `usb_ac(4D)`.

Displaying Information About USB Audio Devices

To list the primary audio device on the system, use the `ls -l` command on the `/dev/audio` device link. As you plug in additional USB devices, the command output identifies the device to which `/dev/audio` connects. This device automatically becomes the primary audio device.

For example, by default, the system's audio is the on-board audio.

```
$ ls -l /dev/audio
lrwxrwxrwx 1 root root 7 Feb 13 08:47 /dev/audio -> sound/0
```

Suppose you connect a USB speaker to the system. The command output would then be as follows:

```
$ ls -l /dev/audio
lrwxrwxrwx 1 root root 10 Feb 13 08:46 /dev/audio -> usb/audio0
```

If you add another audio device, such as a USB microphone, the command output would also change.

```
$ ls -l /dev/audio
lrwxrwxrwx 1 root root 10 Feb 13 08:54 /dev/audio -> usb/audio1
```

To list all the USB audio devices that are connected to the system, use the same `ls` command on all the audio device links.

```
$ ls -lt /dev/audio*
lrwxrwxrwx 1 root root    7 Jul 23 15:46 /dev/audio -> usb/audio0
lrwxrwxrwx 1 root root   10 Jul 23 15:46 /dev/audiocctl ->
usb/audiocctl0/

% ls -lt /dev/sound/*
lrwxrwxrwx 1 root root    74 Jul 23 15:46 /dev/sound/1 ->
../../devices/pci@1f,4000/usb@5/hub@1/device@3/sound-control@0:...
lrwxrwxrwx 1 root root    77 Jul 23 15:46 /dev/sound/1ctl ->
../../devices/pci@1f,4000/usb@5/hub@1/device@3/sound-control@0:...
lrwxrwxrwx 1 root other  66 Jul 23 14:21 /dev/sound/0 ->
../../devices/pci@1f,4000/ebus@1/SUNW,CS4231@14,200000:sound,audio
lrwxrwxrwx 1 root other  69 Jul 23 14:21 /dev/sound/0ctl ->
../../devices/pci@1f,4000/ebus@1/SUNW,CS4231@14,200000:sound,audiocctl
```

Note that despite the multiple audio devices, the `/dev/usb/audio0` is the primary audio device.

You can also use the `prtconf` command to display USB device information.

```
$ prtconf
.
usb, instance #0
hub, instance #0
mouse, instance #0
keyboard, instance #1
device, instance #0
sound-control, instance #0
sound, instance #0
input, instance #0
.
```

To change the primary audio device to a USB audio device, plug the USB device to the system. The `/dev/audio` link automatically points to this device. To revert to using the on-board audio device, simply remove the USB device.

Troubleshooting USB Audio Device Problems

Sometimes, USB speakers do not produce any sound, even though the driver is attached and the volume is set to high. Hot-plugging the device might not change this behavior.

To restore sound, power cycle the USB speakers.

About Audio Device Ownership

When you plug in a USB audio device while logged in to the console, the console is the owner of the `/dev/*` entries. Therefore, you can use the audio device provided you remain logged in. If you were not logged in, then root is the owner of the device. However, if you log in to the console and attempt to access the USB audio device, then device ownership changes to the console. For more information, see the [logindevperm\(5\)](#) man page.

The behavior is different with remote logins. If you attempt to access the device remotely, the ownership does not change and therefore the device is secure. For example, unauthorized users cannot remotely listen to conversations over a microphone that is owned by someone else.

Problem With Reverting to On-Board Audio Device

You might observe that after removing the USB device, the `/dev/audio` does not point back to `/dev/sound/0`. This error indicates that the system did not revert to using the on-board audio device as the primary audio device. Do one of the following workarounds:

- Shut down the system, and use the `boot -r` command.
- As root, issue the `devfsadm -i` command.

Managing Removable Media

This chapter describes how to manage and access removable media in the Oracle Solaris OS. This chapter covers the following topics:

- [“About Removable Media” on page 241](#)
- [“Managing Removable Media” on page 242](#)
- [“Accessing Removable Media” on page 248](#)
- [“Accessing Removable Media on a Remote System” on page 252](#)

About Removable Media

Removable media services enable you to access removable media but without requiring administrative rights, unlike with manual mounting.

If the media contains a file system and a label, the media label name is used to name the */media/pathname* mount point. If a label is not present, the disk model name is used to name the media, such as */media/cdrom*. A generic *nickname* is used only for legacy symbolic links. For example, */rmdisk/rmdisk0*.

If your system has more than one type of removable device, see the following table for their access points.

TABLE 6 How to Access Data on Removable Media

Media	Unlabeled Media Pathnames	Labeled Media Pathname Examples
Hard disk	<i>/media/usb-disk</i> or the legacy path <i>/rmdisk/rmdisk0</i>	<i>/media/00JB-00CRA0</i>
DVD	<i>/media/cdrom</i>	<i>/media/Oracle_Solaris-n-text-X86</i>

To identify mounted media on your system, use the `rmmount -l` command. For example:

```
# rmmount -l
/dev/dsk/c4t0d3p0      rmdisk5,/media/223UHS-SD-MMC
/dev/dsk/c2t0d0s2      cdrom1,cd1,sr1,Oracle_Solaris-11_1-AI-SPARC,
                       /media/Oracle_Solaris-11_1-AI-SPARC
/dev/dsk/c3t0d0p0      rmdisk2,/media/00JB-00CRA0
```

In the sample output, the mounted devices are as follows:

- /dev/dsk/c4t0d3p0 – CF card in a USB card reader
- /dev/dsk/c2t0d0s2 – DVD-ROM
- /dev/dsk/c3t0d0p0 – Removable USB disk

Removable Media Considerations

File system formats in Oracle Solaris consist of the basic "bit" formatting, in addition to the structure to support an Oracle Solaris file system. The procedures required to prepare a media for each type of file system are different. Therefore, before you format a device, consider which procedure to follow.

About Formatting Removable Media

You can use the `rmformat` command to format and perform other management tasks on removable media. File systems are mounted automatically. So, you might have to unmount media before you can format it, if the media contains an existing file system.

The `rmformat` command has three formatting options:

- `quick` – This option formats media without certification or with limited certification of certain tracks on the media.
- `long` – This option completely formats media. For some devices, the use of this option might include the certification of the whole media by the drive.
- `force` – This option formats completely without user confirmation. On media with a password-protection mechanism, this option clears the password before formatting. On media without password protection, this option forces a long format.

Managing Removable Media

This section covers the following topics:

- [“How to Load Removable Media” on page 243](#)

- [“How to Format a Removable Device \(rmformat\)” on page 244](#)
- [“How to Create a File System on Removable Media” on page 244](#)
- [“How to Create a File System on a DVD-RAM” on page 245](#)
- [“How to Check a File System on Removable Media” on page 246](#)
- [“How to Repair Bad Blocks on Removable Media” on page 247](#)
- [“Applying Read or Write Protection and Password Protection to Removable Media” on page 247](#)
- [“How to Enable or Disable Read and Write Protections” on page 247](#)

▼ How to Load Removable Media

1. Insert the media.

2. Ensure that the media is formatted.

If you aren't sure, insert the media and check the status messages in the system console window, as described in [Step 3](#). If you need to format the media, go to [“How to Format a Removable Device \(rmformat\)” on page 244](#).

3. (Optional) Notify volume management if you are using a legacy, non-USB storage device.

```
$ volcheck -v
```

Two status messages are possible:

media was found	Volume management detected the media and will attempt to mount it in the directory described in “Using Removable Media Names” on page 248 .
-----------------	---

If the media is not formatted properly, additional messages are displayed. You must then format the media before volume management can mount it. For more information, see [“How to Format a Removable Device \(rmformat\)” on page 244](#).

no media was found	Volume management did not detect the media. Ensure that the media is inserted properly, and run <code>volcheck</code> again. If unsuccessful, check the media, which could be damaged. You can also try to mount the media manually.
--------------------	--

4. Verify that the media was mounted by listing its contents.

```
$ ls /media/media-name
```

▼ How to Format a Removable Device (rmformat)

You can use the `rmformat` command to format a removable USB storage device. By default, this command creates two partitions on the media: partition 0 and partition 2 (the whole media).

1. **Verify that removable media service is running. If so, you can use the shorter nickname for the device name.**

```
# svcs hal dbus rmvolmgr
STATE          STIME    FMRI
online         Apr_09   svc:/system/dbus:default
online         Apr_09   svc:/system/hal:default
online         Apr_09   svc:/system/filesystem/rmvolmgr:default
```

For information about restarting removable media services, see [“How to Disable or Enable Removable Media Services” on page 250](#). For information about identifying media device names, see [“Using Removable Media Names” on page 248](#).

2. **Format the device.**

```
$ rmformat -F [ quick | long | force ] device-name
```

where *device-name* includes the full path to the device, such as `/dev/device`.

See [“About Formatting Removable Media” on page 242](#) for more information about `rmformat` formatting options.

If the `rmformat` output indicates bad blocks, see [“How to Repair Bad Blocks on Removable Media” on page 247](#).

3. **(Optional) Label the device.**

```
$ rmformat -b label device-name
```

For information about creating a DOS label, see the `mkfs_pcfs(8)` man page.

▼ How to Create a File System on Removable Media

1. **(Optional) If necessary, format the media.**

2. (Optional) Create an alternate Oracle Solaris partition table.

```
$ rmformat -s slice-file device-name
```

A sample slice file appears similar to the following:

```
slices: 0 = 0, 30MB, "wm", "home" :
1 = 30MB, 51MB :
2 = 0, 94MB, "wm", "backup" :
6 = 81MB, 13MB
```

3. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

4. Determine the appropriate file system type and select one of the following:

```
# mkfs -F FS-type -o FS-type-specific-options device
```

where *FS-type-specific-options* refers to options that are specific to the file system type you are creating.

The following example creates a PCFS file system.

```
# mkfs -F pcfs -o nofdisk,size=9800 /dev/rdisk/c11t0d0p0
```

The following example create a UDFS file system.

```
# mkfs -F udfs /dev/rdisk/c0t1d0p0
```

▼ How to Create a File System on a DVD-RAM

Use this procedure to create a file system on a DVD-RAM.

1. Become an administrator.

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. Create a file system on the DVD-RAM device.

For example, create a UDFS file system, as follows:

```
# mkfs -F udfs /dev/rdisk/c0t0d0s2
```

3. Mount the file system.

For example, mount a UDFS file system, as follows:

```
# mount -F udfs /dev/dsk/c0t0d0s2 /mnt
```

4. **Verify that you can read or write to the file system.**
5. **When finished, eject the DVD-RAM.**

▼ How to Check a File System on Removable Media

1. **Become an administrator.**

For more information, see [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#).

2. **Identify the file system type and select one of the following:**

- **Check a UDFS file system, as follows:**

```
# fsck -F udfs device-name
```

- **Check a PCFS file system, as follows:**

```
# fsck -F pcfs device-name
```

Example 71 Checking a PCFS File System on Removable Media

The following example shows how check the consistency of a PCFS file system on media.

```
# fsck -F pcfs /dev/rdisk/c0t4d0s2
** /dev/rdisk/c0t4d0s2
** Scanning file system meta-data
** Correcting any meta-data discrepancies
1457664 bytes.
0 bytes in bad sectors.
0 bytes in 0 directories.
0 bytes in 0 files.
1457664 bytes free.
512 bytes per allocation unit.
2847 total allocation units.
2847 available allocation units.
```

▼ How to Repair Bad Blocks on Removable Media

You can only use the `rmformat` command to verify, analyze, and repair bad sectors that are found during verification if the drive supports bad block management. Most USB memory sticks do not support bad block management.

If the drive supports bad block management, a best effort is made to rectify the bad block. If the bad block cannot be rectified despite the best effort mechanism, a message indicates the failure to repair the media.

1. Repair bad blocks on removable media.

```
$ rmformat -c block-numbers device-name
```

Supply the block number in decimal, octal, or hexadecimal format from a previous `rmformat` session.

2. Verify the media.

```
$ rmformat -V read device-name
```

Applying Read or Write Protection and Password Protection to Removable Media

You can apply read protection or write protection, and set a password, on removable media that support this feature.

▼ How to Enable or Disable Read and Write Protections

1. Determine whether you want to enable or disable write protection and select the appropriate commands from the following:

■ Enable write protection.

```
$ rmformat -w enable device-name
```

■ Enable read protection.

```
$ rmformat -r enable device-name
```

- **Disable write protection.**

```
$ rmformat -w disable device-name
```

- **Disable read protection.**

```
$ rmformat -r disable device-name
```

Note - Each of these commands includes a prompt to type a password. Specify a valid password.

2. **Verify whether the media's write protection is enabled or disabled.**

```
$ rmformat -p device-name
```

Accessing Removable Media

You can access information on removable media with or without using volume management. For information about accessing information on removable media with GNOME's File Manager, see the GNOME desktop documentation.

This section covers the following procedures:

- [“Using Removable Media Names” on page 248](#)
- [“Guidelines for Accessing Removable Media Data” on page 249](#)
- [“How to Add a New Removable Media Drive” on page 249](#)
- [“How to Disable or Enable Removable Media Services” on page 250](#)
- [“How to Access Information on Removable Media” on page 251](#)
- [“How to Determine If Removable Media Is Still in Use” on page 251](#)
- [“How to Eject Removable Media” on page 252](#)

Using Removable Media Names

Removable media is now mounted automatically in the `/media` directory. However, symbolic links to `/media` are provided from previous media mount points, `/cdrom` and `/rmdisk`, for compatibility purposes.

For example, a compact flash memory card (`/dev/dsk/c4d0p0:1`) is mounted as follows:

```
$ ls /media/memory-card-name
```

For example, a USB memory stick (`/dev/dsk/c3t0d0s0`) is mounted, as follows:

```
$ ls /media/U3
```

Guidelines for Accessing Removable Media Data

Most DVDs are formatted to the ISO 9660 standard, which is portable. So, DVDs can be mounted by volume management.

To accommodate possible different formats, a DVD is split into slices. Slices are similar in effect to partitions on hard disks. The 9660 portion is portable. If you are having trouble mounting a DVD, particularly if it is an installation DVD, make sure that its file system is appropriate for your system's architecture. For example, you can check the label on DVD.

▼ How to Add a New Removable Media Drive

Generally, most modern bus types support hot-plugging. This means you can insert a disk in an empty slot and the system recognizes it.

For more information about hot-plugging devices, see [Chapter 2, “Dynamically Configuring Devices”](#).

- 1. Become an administrator.**
- 2. Connect the new media drive.**
See your hardware handbook for specific instructions.
- 3. Confirm that the system sees the new media drive.**

```
# rmformat  
Looking for devices...
```

▼ How to Disable or Enable Removable Media Services

Occasionally, you might want to manage media without using removable media services. This section describes how to disable and enable removable media services.

Disabling these services means that you would have to mount all media manually by using the mount command.

1. **Ensure that the media is not being used.**

If you are not sure whether you have found all users of the media, use the `fuser` command, see [“How to Determine If Removable Media Is Still in Use” on page 251](#).

2. **Become an administrator.**

3. **Select one of the following:**

- **You can disable some or all removable media features in this release:**

- **To prevent volumes from mounting outside of user sessions, disable the `rmvolmgr` service. For example:**

```
# svcadm disable rmvolmgr
```

- **To prevent any volume management, disable the `dbus`, `hal`, and `rmvolmgr` services.**

```
# svcadm disable rmvolmgr
# svcadm disable dbus
# svcadm disable hal
```

Disabling these services means that you would have to mount all media manually by using the mount command.

- **Enable removable media services.**

```
# svcadm enable rmvolmgr
# svcadm enable dbus
# svcadm enable hal
```

▼ How to Access Information on Removable Media

1. Insert the media.

The media is mounted after a few seconds.

2. List the contents of the media. For example:

```
# ls /media/Oracle_Solaris-12_0-text-x86
bin             home            root            tmp
boot           mnt             sbin           varpkg.zlib
dev            platform       solaris.zlib   zvboot
devices        proc           solarismisc.zlib
export         reconfigure    system
```

3. (Optional) Copy the file that you identified in the previous step.

Example 72 Accessing Information on Removable Media

This example shows how to access information on a USB memory stick.

```
$ ls /media/usb-name
```

This example shows how to access information on a DVD.

```
$ ls /media
Oracle_Solaris-12-AI-SPARC cdrom
```

▼ How to Determine If Removable Media Is Still in Use

1. Become an administrator.

2. Identify the processes that are accessing the media.

```
# fuser -u /media
```

The `-u` displays the user of the media.

For more information, see [fuser\(8\)](#).

3. (Optional) Kill the process accessing the media.

```
# fuser -u -k /media
```

The `-k` option terminates the processes accessing the media.



Caution - Terminating the processes that are accessing the media should only be used in emergency situations.

4. **Verify that the process is gone.**

```
# pgrep process-ID
```

▼ How to Eject Removable Media

1. **Ensure that the media is not being used.**

Remember, media is "being used" if a shell or an application is accessing any of its files or directories. If you are not sure whether you have found all users of a DVD (for example, a shell hidden behind a desktop tool might be accessing it), use the `fuser` command. See [“How to Determine If Removable Media Is Still in Use” on page 251](#).

2. **Eject the media.**

```
# eject media
```

For example, for a DVD, you would do the following:

```
# eject cdrom
```

For example, for a USB memory stick, you would do the following:

```
# eject rmdisk0
```

Tip - You can view the removable device name with the `eject -l` command.

Accessing Removable Media on a Remote System

Removable media can be shared with remote systems by using NFS. For additional information about using NFS, see [Managing Network File Systems in Oracle Solaris 11.4](#).

This section contains the following procedures:

- [“How to Make Local Media Available to Other Systems” on page 253](#)

- [“How to Access Removable Media on Remote Systems” on page 254](#)

▼ How to Make Local Media Available to Other Systems

You can configure your system to share its media drives to make any media in those drives available to other systems. One exception is musical CDs. Once your media drives are shared, other systems can access the media they contain simply by mounting them. For instructions, see [“How to Access Removable Media on Remote Systems” on page 254](#).

1. **Confirm that the media is loaded.**
2. **Share the file system by using the `share` command.**
For example:
3. **Determine whether the NFS server service is running.**

```
# svcs nfs/server
```

The following output is returned from the `svcs` command if NFS server service is running:

```
online          14:28:43 svc:/network/nfs/server:default
```

4. **Identify the NFS server status, and select one of the following:**
 - If the NFS server service is running, go to [Step 7](#).
 - If the NFS server service is *not* running, go to the next step.

5. **Start the NFS server service.**

```
# svcadm enable network/nfs/server
```

6. **Verify that the NFS daemons are running.**

For example:

```
# svcs -p svc:/network/nfs/server:default
STATE      STIME    FMRI
online     Aug_30   svc:/network/nfs/server:default
Aug_30     319     mountd
```

```
Aug_30      323 nfsd
```

7. Verify that the media is available to other systems.

If the media is available, its share configuration is displayed.

```
# share
-          /media/Oracle_Solaris-11_3-AI-SPARC  sec=sys,ro  ""
```

Example 73 Making Local DVDs Available to Other Systems

The following example shows how to make any local DVD available to other systems on the network.

```
# share -F nfs /media
# svcs *nfs*
# svcadm enable network/nfs/server
# svcs -p svc:/network/nfs/server:default
# share
-          /media/Oracle_Solaris-11_3-AI-SPARC  ro  ""
```

▼ How to Access Removable Media on Remote Systems

You can access media on a remote system by manually mounting the media into your file system. Also, the remote system must have shared its media according to the instructions in [“How to Make Local Media Available to Other Systems” on page 253](#).

1. Select an existing directory to serve as the mount point. Or create a mount point.

```
$ mkdir /directory
```

where */directory* is the name of the directory that you create to serve as a mount point for the remote system's DVD.

2. Find the name of the media that you want to mount.

```
$ showmount -e system-name
```

3. As an administrator, mount the media.

```
# mount -F nfs -o ro system-name/:media/media-name local-mount-point
```

system-name: Is the name of the system whose media you will mount.

media-name Is the name of the media you want to mount.

local-mount-point Is the local directory onto which you will mount the remote media.

4. **Log out as an administrator.**
5. **Verify that the media has been mounted.**

```
$ ls /mnt
```

Example 74 Accessing DVDs or CDs on Remote Systems

The following example shows how to automatically access the remote DVD from the remote system `global` using `autofs`.

```
$ showmount -e global
export list for global:
/media/Oracle_Solaris-11_3-AI-SPARC (everyone)
$ ls /net/starbug/media/
Oracle_Solaris-11_3-AI-SPARC
```


◆◆◆ APPENDIX A

The format command Reference

This appendix describes the menus and commands that are part of the format command. This is a list of the reference information in this chapter.

- [“Recommendations and Requirements for Using the format Command” on page 257](#)
- [“Menu and Command Descriptions for the format Command” on page 257](#)
- [“Rules for Input to the format Command” on page 263](#)
- [“Getting Help on the format Command” on page 265](#)

Recommendations and Requirements for Using the format Command

You must assume the root role or become an administrator to use the format command. See [“Using Your Assigned Administrative Rights” in *Securing Users and Processes in Oracle Solaris 11.4*](#). Otherwise, the following error message is displayed when you try to use the format command.

```
$ format
Searching for disks...done
No permission (or no disks found)!
```

Menu and Command Descriptions for the format Command

The format menu contents are displayed as follows:

```
FORMAT MENU:
disk      - select a disk
type     - select (define) a disk type
partition - select (define) a partition table
```

```

current    - describe the current disk
format     - format and analyze the disk
fdisk      - run the fdisk program (x86 only)
repair     - repair a defective sector
label      - write label to the disk
analyze    - surface analysis
defect     - defect list management
backup     - search for backup labels
verify     - read and display labels
save       - save new disk/partition definitions
inquiry    - show vendor, product and revision
volname    - set 8-character volume name
!<cmd>    - execute <cmd>, then return
quit
format>
    
```

The following table describes the main menu items for the `format` command.

TABLE 7 The Main Menu Item Descriptions for the `format` Command

Menu Item	Command or Menu?	Description
disk	Command	Lists all of the system's drives. Also lets you choose the disk you want to use in subsequent operations. This disk is referred to as the current disk.
type	Command	Identifies the manufacturer and model of the current disk. Also displays a list of known drive types. Choose the <code>Auto configure</code> option for all SCSI-2 disk drives.
partition	Menu	Creates and modifies slices. For more information, see “partition Menu” on page 259 .
current	Command	Displays the following information about the current disk: <ul style="list-style-type: none"> ■ Device name and device type ■ Number of cylinders, alternate cylinders, heads and sectors ■ Physical device name
format	Command	Formats the current disk by using one of these sources of information in this order: <ol style="list-style-type: none"> 1. Information from the automatic configuration process 2. Information that you type at the prompt <p>This command does not apply to IDE disks. IDE disks are preformatted by the manufacturer.</p>
fdisk	Menu	x86 platform only: Runs the <code>fdisk</code> program to create a Solaris <code>fdisk</code> partition. <p>The <code>fdisk</code> command cannot be used on disks with an EFI label that are greater than 1 terabyte in size.</p>
repair	Command	Repairs a specific block on the current disk.

Menu Item	Command or Menu?	Description
label	Command	Writes a new label to the current disk.
analyze	Menu	Runs read, write, and compare tests. For more information, see “analyze Menu” on page 261 .
defect	Menu	Retrieves and displays defect lists. For more information, see “defect Menu” on page 262 . This feature does not apply to IDE disks. IDE disks manage defects automatically.
backup	Command	VTOC – Searches for backup labels. EFI – Not supported.
verify	Command	Displays the following information about the current disk: <ul style="list-style-type: none"> ■ Device name and device type ■ Number of cylinders, alternate cylinders, heads and sectors ■ Partition table
save	Command	VTOC – Saves new disk and partition information. EFI – Not applicable.
inquiry	Command	SCSI disks only – Displays the vendor, product name, and revision level of the current drive.
volname	Command	Labels the disk with a new eight-character volume name that you specify.
quit	Command	Exits the Format menu.

partition Menu

The partition menu contents are displayed as follows:

```
format> partition
PARTITION MENU:
0      - change `0' partition
1      - change `1' partition
2      - change `2' partition
3      - change `3' partition
4      - change `4' partition
5      - change `5' partition
6      - change `6' partition
7      - change `7' partition
select - select a predefined table
modify - modify a predefined partition table
name   - name the current table
print  - display the current table
label  - write partition map and label to the disk
quit
```

partition>

The following table describes the partition menu items.

TABLE 8 Descriptions for partition Menu Items

Subcommand	Description
change `n` partition	Enables you to specify the following information for the new partition: <ul style="list-style-type: none"> ■ Identification tag ■ Permission flags ■ Starting cylinder ■ Size
select	Enables you to choose a predefined partition table.
modify	Enables you to change all the slices in the partition table. This command is preferred over the individual change `x` partition commands.
name	Enables you to specify a name for the current partition table.
print	Displays the current partition table.
label	Writes the partition map and the label to the current disk.
quit	Exits the partition menu.

x86: fdisk Menu

The `fdisk` menu is available on x86 based systems only and appears similar to the following.

```
format> fdisk
Total disk size is 8924 cylinders
Cylinder size is 16065 (512 byte) blocks

Cylinders
Partition  Status  Type           Start  End  Length  %
=====  =====  =====
1          EFI          0 8924  8925  100

SELECT ONE OF THE FOLLOWING:
1. Create a partition
2. Specify the active partition
3. Delete a partition
4. Change between Solaris and Solaris2 Partition IDs
5. Edit/View extended partitions
6. Exit (update disk configuration and exit)
```

7. Cancel (exit without updating disk configuration)
Enter Selection:

The following table describes the fdisk menu items.

TABLE 9 x86: Descriptions for fdisk Menu Items

Menu Item	Description
Create a partition	Creates an fdisk partition. You must create a separate partition for each OS such as Oracle Solaris or DOS. There is a maximum of four partitions per disk. You are prompted for the size of the fdisk partition as a percentage of the disk.
Specify the active partition	Enables you to specify the partition to be used for booting. This menu item identifies where the first stage boot program looks for the second stage boot program.
Delete a partition	Deletes a previously created partition. This command destroys all the data in the partition.
Change between Solaris and Solaris2 Partition IDs	Changes partition IDs from 130 (0x82) to 191 (0xbf) and back again.
Edit/View extended partitions	Manages partition information that is generally used for booting.
Exit (update disk configuration and exit)	Writes a new version of the partition table and exits the fdisk menu.
Cancel (exit without updating disk configuration)	Exits the fdisk menu without modifying the partition table.

analyze Menu

The analyze menu contents are displayed as follows:

```
format> analyze
```

```
ANALYZE MENU:
```

```
read      - read only test   (doesn't harm SunOS)
refresh  - read then write  (doesn't harm data)
test     - pattern testing  (doesn't harm data)
write    - write then read   (corrupts data)
compare  - write, read, compare (corrupts data)
purge    - write, read, write (corrupts data)
verify   - write entire disk, then verify (corrupts data)
print    - display data buffer
setup    - set analysis parameters
config   - show analysis parameters
quit
analyze>
```

The following table describes the analyze menu items.

TABLE 10 Descriptions for analyze Menu Items

Subcommand	Description
<code>read</code>	Reads each sector on the current disk. Repairs defective blocks as a default.
<code>refresh</code>	Reads then writes data on the current disk without harming the data. Repairs defective blocks as a default.
<code>test</code>	Writes a set of patterns to the disk without harming the data. Repairs defective blocks as a default.
<code>write</code>	Writes a set of patterns to the disk then reads back the data on the disk. Destroys existing data on the disk. Repairs defective blocks as a default.
<code>compare</code>	Writes a set of patterns to the disk, reads back the data, and then compares it to the data in the write buffer. Destroys existing data on the disk. Repairs defective blocks as a default.
<code>purge</code>	Removes all data from the disk so that the data cannot be retrieved by any means. Data is removed by writing three distinct patterns over the entire disk (or a section of the disk). If the verification passes, a hex-bit pattern is written over the entire disk (or a section of the disk).
<code>verify</code>	Repairs defective blocks as a default. In the first pass, writes unique data to each block on the entire disk. In the next pass, reads and verifies the data. Destroys existing data on the disk. Repairs defective blocks as a default.
<code>print</code>	Displays the data in the read/write buffer.
<code>setup</code>	Enables you to specify the following analysis parameters: Analyze entire disk? <i>yes</i> Starting block number: <i>depends on drive</i> Ending block number: <i>depends on drive</i> Loop continuously? <i>no</i> Number of passes: <i>2</i> Repair defective blocks? <i>yes</i> Stop after first error? <i>no</i> Use random bit patterns? <i>no</i> Number of blocks per transfer: <i>126 (0/n/nn)</i> Verify media after formatting? <i>yes</i> Enable extended messages? <i>no</i> Restore defect list? <i>yes</i> Restore disk label? <i>yes</i>
<code>config</code>	Displays the current analysis parameters.
<code>quit</code>	Exits the analyze menu.

defect Menu

The defect menu contents are displayed as follows:

```
format> defect

DEFECT MENU:
primary - extract manufacturer's defect list
grown   - extract manufacturer's and repaired defects lists
both    - extract both primary and grown defects lists
print   - display working list
dump    - dump working list to file
quit
defect>
```

The following table describes the `defect` menu items.

TABLE 11 The defect Menu Item Descriptions

Subcommand	Description
primary	Reads the manufacturer's defect list from the disk drive and updates the in-memory defect list.
grown	Reads the grown defect list and then updates the in-memory defect list. Grown defects are defects that have been detected during analysis.
both	Reads both the manufacturer's defect list and the grown defect list. Then, updates the in-memory defect list.
print	Displays the in-memory defect list.
dump	Saves the in-memory defect list to a file.
quit	Exits the defect menu.

Rules for Input to the `format` Command

When you use the `format` command, you need to provide various kinds of information. This section describes the rules for this information. For information about using `format`'s help facility when you specify data, see [“Getting Help on the `format` Command” on page 265](#).

Specifying Numbers to the `format` Command

Several places in the `format` command require number as input. You must either specify the appropriate data or select a number from a list of choices. In either case, the help facility causes `format` to display the upper and lower limits of the number expected. Simply enter the appropriate number. The number is assumed to be in decimal format unless a base is explicitly specified as part of the number (for example, `0x` for hexadecimal).

The following are examples of integer input:

```
Enter number of passes [2]: 34
Enter number of passes [34] 0xf
```

Specifying `format` Command Names

Command names are needed as input whenever the `format` command displays a menu prompt. You can abbreviate the command names, as long as what you type is sufficient to uniquely identify the command desired.

For example, use `p` to access the partition menu from the `format` menu. Then, type `p` to display the current slice table.

```
format> p
PARTITION MENU:
0      - change `0' partition
1      - change `1' partition
2      - change `2' partition
3      - change `3' partition
4      - change `4' partition
5      - change `5' partition
6      - change `6' partition
7      - change `7' partition
select - select a predefined table
modify - modify a predefined partition table
name   - name the current table
print  - display the current table
label  - write partition map and label to the disk
quit
partition> p
```

Specifying Disk Names to `format` Command

At certain points when using the `format` command, you must name something. In these cases, you are free to specify any string you want for the name. If the name has white space in it, the entire name must be enclosed in double quotation marks (`"`). Otherwise, only the first word of the name is used.

For example, if you want to identify a specific partition table for a disk, you can use the name subcommand that is available from the partition menu:

```
partition> name
Enter table name (remember quotes): "new disk3"
```

Getting Help on the `format` Command

The `format` command provides a help facility that you can use whenever the `format` command is expecting input. You can request help about what input is expected by typing a question mark (`?`). The `format` command displays a brief description of what type of input is needed.

If you type a `?` at a menu prompt, a list of available commands is displayed.

See also the [`format\(8\)`](#) man page. It describes the basic `format` command capabilities and provides descriptions of all command-line variables.

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