Managing System Information, Processes, and Performance in Oracle® Solaris 11.3

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Using This Documentation

- **Overview** – Describes tasks for managing system information, processes, and monitoring performance
- **Audience** – System administrators using the Oracle Solaris 11 release
- **Required knowledge** – Experience administering UNIX systems

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♦ ♦ ♦ CHAPTER 1

Managing System Information

This chapter describes the tasks that are required to display and change basic system information.

This chapter covers the following topics:

- "Displaying System Information" on page 15
- "Changing System Information" on page 27

For information about resource management that enables you to allocate, monitor, and control system resources in a flexible way, see Chapter 1, "Introduction to Resource Management" in *Administering Resource Management in Oracle Solaris 11.3*.

Displaying System Information

This section describes commands that enable you to display general system information.

Commands That Are Used to Display System Information

TABLE 1 Commands for Displaying System Information

Command	System Information Displayed	Man Page
`date`	Date and time.	`date`(1)
`hostid`	Host ID number.	`hostid`(1)
`isainfo`	Identifies various attributes of the instruction set architectures supported on the currently running system. Examples of questions that `isainfo` can answer include whether 64-bit applications are supported, or whether the running kernel uses 32-bit or 64-bit device drivers.	`isainfo`(1)
`isalist`	Processor type.	`isalist`(1)

Command	System Information Displayed	Man Page
`prtconf`	System configuration information, installed memory, device properties, and product name.	`prtconf`(1M)
`prtdiag`	System configuration and diagnostic information, including any failed field replacement units (FRUs).	`prtdiag`(1M)
`psrinfo`	Processor information.	`psrinfo`(1M)
`uname`	Operating system name, release, version, node name, hardware name, and processor type.	`uname`(1)

Displaying Release Information

You can use the following command to display the contents of the `/etc/release` file, which helps in identifying your release version.

```
$ cat /etc/release
```

Displaying Date and Time

You can use the `date` command to display the current date and time according to your system clock.

```
$ date
Fri Jun  1 16:07:44 MDT 2012
$
```

Displaying Host ID Number

You can use the `hostid` command to display the host ID number in a numeric (hexadecimal) format.

```
$ hostid
80a5d34c
```

Displaying Architecture Type

You can use the `isainfo` command to display the architecture type and names of the native instruction sets, for applications that are supported by the current operating system.

The following sample output is from an x86 based system:

```
$ isainfo
amd64 i386
```

The following sample output is from a SPARC based system:

```
$ isainfo
sparcv9 sparc
```

The `isainfo -v` command displays 32-bit and 64-bit application support. For example, the following sample output is from a SPARC based system:

```
$ isainfo -v
64-bit sparcv9 applications
        asi_blk_init
32-bit sparc applications
        asi_blk_init v8plus div32 mul32
#
```

The following example shows the output of the `isainfo -v` command from an x86 based system:

```
$ isainfo -v
64-bit amd64 applications
        sse4.1 ssse3 ahf cx16 sse3 sse2 sse fxsr mmx cmov amd_sysc cx8 tsc fpu
32-bit i386 applications
        sse4.1 ssse3 ahf cx16 sse3 sse2 sse fxsr mmx cmov sep cx8 tsc fpu
```

For more information, see the `isainfo(1)` man page.

Displaying Processor Type

You can use the `isalist` command to display information about the processor of a system.

The following sample output is from an x86 based system:

```
$ isalist
pentium_pro+mmx pentium_pro pentium+mmx pentium i486 i386 i86
```

The following sample output is from a SPARC based system:

```
$ isalist
sparcv9 sparcv8plus sparcv8 sparcv8-fsmuld sparcv7 sparc sparcv9+vis sparcv9+vis2 \
```

```
sparcv8plus+vis sparcv8plus+vis2
```

For more information, see the isalist(1) man page.

Displaying Product Name

You can display the product name of your system using the `prtconf` command with the `-b` option:

```
$ prtconf -b
```

For more information, see the prtconf(1M) man page.

The following example shows sample output from the `prtconf -b` command on a SPARC based system:

```
$ prtconf -b
name:  ORCL,SPARC-T4-2
banner-name:  SPARC T4-2
compatible: 'sun4v'
$
```

The following example shows sample output from the `prtconf -vb` command on a SPARC based system. The added `-v` option specifies verbose output.

```
$ prtconf -vb
name:  ORCL,SPARC-T3-4
banner-name:  SPARC T3-4
compatible: 'sun4v'
idprom: 01840014.4fa02d28.00000000.a02d28de.00000000.00000000.00000000.00000000
openprom model:  SUNW,4.33.0.b
openprom version: 'OBP 4.33.0.b 2011/05/16 16:26'
```

Displaying Installed Memory

You can display the amount of memory that is installed on your system using the `prtconf` command with the `grep Memory` command. The following example shows a sample output, where the `grep Memory` command selects output from the `prtconf` command to display memory information only:

```
$ prtconf | grep Memory
Memory size: 523776 Megabytes
```

Displaying Default and Customized Property Values for a Device

You can use the `prtconf -u` command to display the default and customized property values for devices.

```
$ prtconf -u
```

The output of the `prtconf -u` command displays the default and customized properties for all of the drivers that are installed on the system.

For more information about this option, see the `prtconf(1M)` man page.

EXAMPLE 1 SPARC: Displaying Default and Custom Device Properties

This example shows the default and custom properties for the `bge.conf` file. Note that vendor-provided configuration files are located in the `/kernel` and `/platform` directories, while the corresponding modified driver configuration files are located in the `/etc/driver/drv` directory.

```
$ prtconf -u
System Configuration:  Oracle Corporation  sun4v
Memory size: 523776 Megabytes
System Peripherals (Software Nodes):

ORCL,SPARC-T3-4
    scsi_vhci, instance #0
        disk, instance #4
        disk, instance #5
        disk, instance #6
        disk, instance #8
        disk, instance #9
        disk, instance #10
        disk, instance #11
        disk, instance #12
    packages (driver not attached)
        SUNW,builtin-drivers (driver not attached)
        deblocker (driver not attached)
        disk-label (driver not attached)
        terminal-emulator (driver not attached)
        dropins (driver not attached)
        SUNW,asr (driver not attached)
        kbd-translator (driver not attached)
        obp-tftp (driver not attached)
        zfs-file-system (driver not attached)
        hsfs-file-system (driver not attached)
```

```
    chosen (driver not attached)
    openprom (driver not attached)
        client-services (driver not attached)
    options, instance #0
    aliases (driver not attached)
    memory (driver not attached)
    virtual-memory (driver not attached)
    iscsi-hba (driver not attached)
        disk, instance #0 (driver not attached)
    virtual-devices, instance #0
        flashprom (driver not attached)
        tpm, instance #0 (driver not attached)
        n2cp, instance #0
        ncp, instance #0
        random-number-generator, instance #0
        console, instance #0
        channel-devices, instance #0
            virtual-channel, instance #0
            virtual-channel, instance #1
            virtual-channel-client, instance #2
            virtual-channel-client, instance #3
            virtual-domain-service, instance #0
    cpu (driver not attached)
    cpu (driver not attached)
    cpu (driver not attached)
    cpu (driver not attached)
    cpu (driver not attached)
    cpu (driver not attached)
    cpu (driver not attached)
```

EXAMPLE 2 x86: Displaying Default and Custom Device Properties

This example shows the default and custom properties for the `bge.conf` file. Note that vendor-provided configuration files are located in the `/kernel` and `/platform` directories, while the corresponding modified driver configuration files are located in the `/etc/driver/drv` directory.

```
$ prtconf -u
System Configuration:  Oracle Corporation  i86pc
Memory size: 8192 Megabytes
System Peripherals (Software Nodes):

i86pc
    scsi_vhci, instance #0
    pci, instance #0
        pci10de,5e (driver not attached)
        isa, instance #0
            asy, instance #0
```

```
        motherboard (driver not attached)
        pit_beep, instance #0
    pci10de,cb84 (driver not attached)
    pci108e,cb84, instance #0
        device, instance #0
            keyboard, instance #0
            mouse, instance #1
    pci108e,cb84, instance #0
    pci-ide, instance #0
        ide, instance #0
            sd, instance #0
        ide (driver not attached)
    pci10de,5c, instance #0
        display, instance #0
    pci10de,cb84, instance #0
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci1022,1100, instance #0
    pci1022,1101, instance #1
    pci1022,1102, instance #2
    pci1022,1103 (driver not attached)
    pci1022,1100, instance #3
    pci1022,1101, instance #4
    pci1022,1102, instance #5
    pci1022,1103 (driver not attached)
pci, instance #1
    pci10de,5e (driver not attached)
    pci10de,cb84 (driver not attached)
    pci10de,cb84, instance #1
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci10de,5d (driver not attached)
    pci1022,7458, instance #1
    pci1022,7459 (driver not attached)
    pci1022,7458, instance #2
        pci8086,1011, instance #0
        pci8086,1011, instance #1
        pci1000,3060, instance #0
            sd, instance #1
            sd, instance #2
    pci1022,7459 (driver not attached)
ioapics (driver not attached)
    ioapic, instance #0 (driver not attached)
    ioapic, instance #1 (driver not attached)
fw, instance #0
```

```
        cpu (driver not attached)
        cpu (driver not attached)
        cpu (driver not attached)
        cpu (driver not attached)
        sb, instance #1
    used-resources (driver not attached)
    iscsi, instance #0
    fcoe, instance #0
    pseudo, instance #0
    options, instance #0
    xsvc, instance #0
    vga_arbiter, instance #0
```

EXAMPLE 3 x86: Displaying System Configuration Information

This example shows how to use the `prtconf` command with the `-v` option on an x86 based system to identify which disk, tape, and DVD devices are connected to the system. The output of this command displays `driver not attached` messages next to the device instances for which no device exists.

```
$ prtconf -v | more
System Configuration:  Oracle Corporation  i86pc
Memory size: 8192 Megabytes
System Peripherals (Software Nodes):

i86pc
    System properties:
        name='#size-cells' type=int items=1
            value=00000002
        name='#address-cells' type=int items=1
            value=00000003
        name='relative-addressing' type=int items=1
            value=00000001
        name='MMU_PAGEOFFSET' type=int items=1
            value=00000fff
        name='MMU_PAGESIZE' type=int items=1
            value=00001000
        name='PAGESIZE' type=int items=1
            value=00001000
        name='acpi-status' type=int items=1
            value=00000013
        name='biosdev-0x81' type=byte items=588
            value=01.38.74.0e.08.1e.db.e4.fe.00.d0.ed.fe.f8.6b.04.08.d3.db.e4.fe
.
.
.
```

For more information, see the driver(4), driver.conf(4), and prtconf(1M) man pages.

For instructions on how to create administratively provided configuration files, see Chapter 1, "Managing Devices in Oracle Solaris" in *Managing Devices in Oracle Solaris 11.3*.

Displaying System Diagnostic Information

You can use the prtdiag command to display configuration and diagnostic information for a system.

```
$ prtdiag [-v] [-l]
```

-v Verbose mode.

-l Log output. If failures or errors exist in the system, output this information to syslogd(1M) only.

EXAMPLE 4 SPARC: Displaying System Diagnostic Information

This example shows the output for the prtdiag -v command on a SPARC based system. For the sake of brevity, the example has been truncated.

```
$ prtdiag -v | more
System Configuration:  Oracle Corporation  sun4v Sun Fire T200
Memory size: 16256 Megabytes

================================ Virtual CPUs ================================


CPU ID Frequency Implementation         Status
------ --------- ---------------------- -------
0      1200 MHz  SUNW,UltraSPARC-T1     on-line
1      1200 MHz  SUNW,UltraSPARC-T1     on-line
2      1200 MHz  SUNW,UltraSPARC-T1     on-line
3      1200 MHz  SUNW,UltraSPARC-T1     on-line
4      1200 MHz  SUNW,UltraSPARC-T1     on-line
5      1200 MHz  SUNW,UltraSPARC-T1     on-line
6      1200 MHz  SUNW,UltraSPARC-T1     on-line
.
.
.
====================== Physical Memory Configuration ======================
Segment Table:
------------------------------------------------------------
Base           Segment  Interleave  Bank     Contains
```

```
Address        Size     Factor      Size     Modules
-------------------------------------------------------------
0x0            16 GB    4           2 GB     MB/CMP0/CH0/R0/D0
                                             MB/CMP0/CH0/R0/D1
                                    2 GB     MB/CMP0/CH0/R1/D0
                                             MB/CMP0/CH0/R1/D1
                                    2 GB     MB/CMP0/CH1/R0/D0
                                             MB/CMP0/CH1/R0/D1
                                    2 GB     MB/CMP0/CH1/R1/D0
.
.
System PROM revisions:
----------------------
OBP 4.30.4.d 2011/07/06 14:29

IO ASIC revisions:
------------------
Location             Path                                    Device
                  Revision
-------------------- ------------------
IOBD/IO-BRIDGE                                    /pci@780      SUNW,sun4v-pci     0
.
.
.
```

EXAMPLE 5 x86: Displaying System Diagnostic Information

This example shows the output for the `prtdiag -l` command on an x86 based system.

```
$ prtdiag -l
System Configuration: ... Sun Fire X4100 M2
BIOS Configuration: American Megatrends Inc. 0ABJX104 04/09/2009
BMC Configuration: IPMI 1.5 (KCS: Keyboard Controller Style)

==== Processor Sockets ====================================

Version                          Location Tag
-------------------------------- ------------------------
Dual-Core AMD Opteron(tm) Processor 2220 CPU 1
Dual-Core AMD Opteron(tm) Processor 2220 CPU 2

==== Memory Device Sockets ================================

Type        Status Set Device Locator      Bank Locator
----------- ------ --- ------------------ ----------------
unknown     empty  0   DIMM0                NODE0
unknown     empty  0   DIMM1                NODE0
DDR2        in use 0   DIMM2                NODE0
```

```
DDR2        in use 0   DIMM3               NODE0
unknown     empty  0   DIMM0               NODE1
unknown     empty  0   DIMM1               NODE1
DDR2        in use 0   DIMM2               NODE1
DDR2        in use 0   DIMM3               NODE1

==== On-Board Devices ==================================
 LSI serial-SCSI #1
 Gigabit Ethernet #1
 ATI Rage XL VGA

==== Upgradeable Slots ==================================

ID  Status    Type             Description
--- --------- ---------------- ----------------------------
1   available PCI Express      PCIExp SLOT0
2   available PCI Express      PCIExp SLOT1
3   available PCI-X            PCIX SLOT2
4   available PCI Express      PCIExp SLOT3
5   available PCI Express      PCIExp SLOT4
$
```

Chip Multithreading Features

The `psrinfo` command has been modified to provide information about physical processors in addition to information about virtual processors. This enhanced functionality has been added to identify chip multithreading (CMT) features. The `-p` option reports the total number of physical processors that are in a system. The `-t` option displays a tree of the processors of the system and their associated socket, core, and CPU IDs.

Using the `psrinfo -pv` command lists all the physical processors that are in the system as well as the virtual processors that are associated with each physical processor. The default output of the `psrinfo` command continues to display the virtual processor information for a system.

For more information, see the `psrinfo`(1M) man page.

Displaying the Physical Processor Type of a System

You can use the `psrinfo -p` command to display the total number of physical processors on a system.

```
$ psrinfo -p
1
```

You can use the `--v` option to display information about the virtual processor that is associated with each physical processor.

This example shows the sample output for the `psrinfo-pv` command on a SPARC based system.

```
$ psrinfo -pv
The physical processor has 8 cores and 32 virtual processors (0-31)
  The core has 4 virtual processors (0-3)
  The core has 4 virtual processors (4-7)
  The core has 4 virtual processors (8-11)
  The core has 4 virtual processors (12-15)
  The core has 4 virtual processors (16-19)
  The core has 4 virtual processors (20-23)
  The core has 4 virtual processors (24-27)
  The core has 4 virtual processors (28-31)
    UltraSPARC-T1 (chipid 0, clock 1000 MHz)
```

The following example shows sample output for the `psrinfo -pv` command on an x86 based system.

```
$ psrinfo -pv
The physical processor has 2 virtual processors (0 1)
  x86 (AuthenticAMD 40F13 family 15 model 65 step 3 clock 2793 MHz)
        Dual-Core AMD Opteron(tm) Processor 2220        [ Socket: F(1207) ]
The physical processor has 2 virtual processors (2 3)
  x86 (AuthenticAMD 40F13 family 15 model 65 step 3 clock 2793 MHz)
        Dual-Core AMD Opteron(tm) Processor 2220        [ Socket: F(1207) ]
```

Displaying the Virtual Processor Type of a System

You can use the `psrinfo -v` command to display the virtual processor type on a SPARC based system.

```
$ psrinfo -v
```

You can use the `isalist` command to display the virtual processor type on an x86 based system.

```
$ isalist
amd64 pentium_pro+mmx pentium_pro pentium+mmx pentium i486 i386 i86
```

EXAMPLE 6 SPARC: Displaying the Virtual Processor Type of a System

This example shows how to display the virtual processor type on a SPARC based system.

```
$ psrinfo -v
Status of virtual processor 28 as of: 09/13/2010 14:07:47
  on-line since 04/08/2010 21:27:56.
  The sparcv9 processor operates at 1400 MHz,
        and has a sparcv9 floating point processor.
Status of virtual processor 29 as of: 09/13/2010 14:07:47
  on-line since 04/08/2010 21:27:56.
  The sparcv9 processor operates at 1400 MHz,
        and has a sparcv9 floating point processor.
```

EXAMPLE 7 SPARC: Displaying the Virtual Processor That Is Associated With Each Physical Processor on a System

This example shows the output of the `psrinfo` command, when run with the `-pv` options on an Oracle SPARC T4-4 server. The output displays both the chip (physical processor) and the core information about the thread location. This information can be helpful in determining which physical CPU a thread is on, and how it is mapped at the core level.

```
$ psrinfo -pv
The physical processor has 8 cores and 64 virtual processors (0-63)
  The core has 8 virtual processors (0-7)
  The core has 8 virtual processors (8-15)
  The core has 8 virtual processors (16-23)
  The core has 8 virtual processors (24-31)
  The core has 8 virtual processors (32-39)
  The core has 8 virtual processors (40-47)
  The core has 8 virtual processors (48-55)
  The core has 8 virtual processors (56-63)
    SPARC-T4 (chipid 0, clock 2998 MHz)
The physical processor has 8 cores and 64 virtual processors (64-127)
  The core has 8 virtual processors (64-71)
  The core has 8 virtual processors (72-79)
  The core has 8 virtual processors (80-87)
  The core has 8 virtual processors (88-95)
  The core has 8 virtual processors (96-103)
  The core has 8 virtual processors (104-111)
  The core has 8 virtual processors (112-119)
  The core has 8 virtual processors (120-127)
    SPARC-T4 (chipid 1, clock 2998 MHz)
```

Changing System Information

This section describes commands that enable you to change general system information.

Changing System Information Task Map

Task	Directions	For Instructions
Manually set the date and time of a system.	Manually set the date and time of your system by using the `date` *mmddHHMM[[cc]yy]* command-line syntax.	"How to Manually Set the Date and Time of a System" on page 28
Set up a message-of-the-day.	Set up a message-of-the-day on your system by editing the `/etc/motd` file.	"How to Set Up a Message-Of-The-Day" on page 29
Change identity of the system.	Change the identity of your system by using the `hostname` command.	"How to Change the Identity of a System" on page 29

▼ How to Manually Set the Date and Time of a System

1. **Become an administrator.**
   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Provide the new date and time.**

   `$ date` *mmddHHMM[[cc]yy]*

mm	Month, using two digits
dd	Day of the month, using two digits
HH	Hour, using two digits and a 24-hour clock
MM	Minutes, using two digits
cc	Century, using two digits
yy	Year, using two digits

   For more information, see the `date`(1) man page.

3. **Verify that you have reset the date of your system correctly by using the `date` command with no options.**

Example 8 Manually Setting the Date and Time of a System

The following example shows how to use the `date` command to manually set the date and time of a system.

```
# date
Monday, September 13. 2010 02:00:16 PM MDT
# date 0921173404
Thu Sep 17:34:34 MST 2010
```

How to Set Up a Message-Of-The-Day

You can edit the message-of-the-day file, `/etc/motd`, to include announcements or inquiries to all users of a system when they log in. Use this feature sparingly, and edit this file regularly to remove obsolete messages.

1. **Assume a role that has the `Administrator Message Edit` profile assigned to it.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Use the `pfedit` command to edit the `/etc/motd` file and add a message of your choice.**

   ```
   $ pfedit /etc/motd
   ```

   Edit the text to include the message that will be displayed during user login. Include spaces, tabs, and carriage returns.

3. **Verify the changes by displaying the contents of the `/etc/motd` file.**

   ```
   $ cat /etc/motd
   Welcome to the UNIX universe. Have a nice day.
   ```

How to Change the Identity of a System

1. **Become an administrator.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Set the name of the host for the system.**

```
# hostname name
```

The `hostname` and `domainname` commands enable you to permanently set the host name and domain name. When you use these commands, the corresponding SMF properties and associated SMF service, are also automatically updated.

For more information, see the `hostname(1)`, `domainname(1M)`, and `nodename(4)` man pages.

♦ ♦ ♦ CHAPTER 2

Managing System Processes

This chapter describes procedures for managing system processes.

This chapter covers the following topics:

System Processes That do not Require Administration

The Oracle Solaris 10 and Oracle Solaris 11 releases include system processes that perform a specific task but do not require any administration.

Process	Description
`fsflush`	System daemon that flushes pages to disk
`init`	Initial system process that starts and restarts other processes and SMF components
`intrd`	System process that monitors and balances system load due to interrupts
`kmem_task`	System process that monitors memory cache sizes
`pageout`	System process that controls memory paging to disk
`sched`	System process that is responsible for OS scheduling and process swapping
`vm_tasks`	System process with one thread per processor that balances and distributes virtual memory related workloads across CPUs for better performance.
`zpool-`*pool-name*	System process for each ZFS storage pool containing the I/O task threads for the associated pool

Managing System Processes

This section describes the various tasks for managing system processes.

Managing System Processes Task Map

Task	Description	For Instructions
List processes.	Use the `ps` command to list all the processes on a system.	"How to List Processes" on page 36
Display information about processes.	Use the `pgrep` command to obtain the process IDs of the processes that you want to display more information about.	"How to Display Information About Processes" on page 37
Control processes.	Locate processes by using the `pgrep` command. Then, use the appropriate `pcommand` (`/proc`) to control the process. For a description of the `/proc` commands, see Table 3, "Process Commands (`/proc`)," on page 34.	"How to Control Processes" on page 38
Kill a process.	Locate a process, either by process name or process ID. You can use either the `pkill` or `kill` commands to terminate the process.	"How to Terminate a Process Using the `pkill` Command" on page 39 "How to Terminate a Process Using the `kill` Command" on page 40

Commands for Managing System Processes

The following table describes the commands for managing system processes.

TABLE 2 Commands for Managing Processes

Command	Description	Man Page
`ps`, `pgrep`, `prstat`, `pkill`	Check the status of active processes on a system, and also displays detailed information about the processes.	`ps`(1), `pgrep`(1), and `prstat`(1M)
`pkill`	Functions identically to `pgrep` but finds or signals processes by name or other attribute, and terminates the process. Instead of having the process ID printed, each matching	`pgrep`(1), and `pkill`(1) `kill`(1)

Command	Description	Man Page
	process is signaled similar to the `kill` command.	
`pargs, preap`	Assists with process debugging.	`pargs`(1) and `preap`(1)
`dispadmin`	Lists default process scheduling policies.	`dispadmin`(1M)
`priocntl`	Assigns processes to a priority class and manages process priorities.	`priocntl`(1)
`nice`	Changes the priority of a timesharing process.	`nice`(1)
`psrset`	Binds specific process groups to a group of processors rather than to just a single processor.	`psrset`(1M)

Using the `ps` Command

The `ps` command enables you to check the status of active processes on a system, and also display technical information about the processes. This data is useful for administrative tasks, such as determining how to set process priorities.

Depending on which options you use, the `ps` command reports the following information:

- Current status of the process
- Process ID
- Parent process ID
- User ID
- Scheduling class
- Priority
- Address of the process
- Memory used
- CPU time used

The following list describes some fields that are reported by the `ps` command. The fields that are displayed depend on which option you choose. For a description of all available options, see the `ps`(1) man page.

`UID` The effective user ID of the owner of the process.

`PID` The process ID.

`PPID` The parent process ID.

`C` The processor utilization for scheduling. This field is not displayed when the `-c` option is used.

CLS	The scheduling class to which the process belongs such as real-time, system, or timesharing. This field is included only with the -c option.
PRI	The scheduling priority of the kernel thread. Higher numbers indicate a higher priority.
NI	The nice number of the process, which contributes to its scheduling priority. Making a process “nicer” means lowering its priority.
ADDR	The address of the proc structure.
SZ	The virtual address size of the process.
WCHAN	The address of an event or lock for which the process is sleeping.
STIME	The starting time of the process in hours, minutes, and seconds.
TTY	The terminal from which the process, or its parent, was started. A question mark indicates that there is no controlling terminal.
TIME	The total amount of CPU time used by the process since it began.
CMD	The command that generated the process.

Using the /proc File System and Commands

You can display detailed information about the processes that are listed in the /proc directory by using process commands. The following table lists the /proc process commands. The /proc directory is also known as the process file system (PROCFS). Images of active processes are stored in the PROCFS by their process ID number.

TABLE 3 Process Commands (/proc)

Process Command	Description
pcred	Displays process credential information
pfiles	Reports fstat and fcntl information for open files in a process
pflags	Displays /proc tracing flags, pending signals and held signals, and other status information
pldd	Lists the dynamic libraries that are linked into a process
pmap	Displays the address space map of each process
psig	Lists the signal actions and handlers of each process
prun	Starts each process

Process Command	Description
`pstack`	Displays a hex+symbolic stack trace for each lightweight process in each process
`pstop`	Stops each process
`ptime`	Times a process by using microstate accounting
`ptree`	Displays the process trees that contain the process
`pwait`	Displays status information after a process terminates
`pwdx`	Displays the current working directory for a process

For more information, see the `proc`(1) man page.

The process tools are similar to some options of the `ps` command, except that the output that is provided by these commands is more detailed.

The process commands perform the following tasks:

- Display more information about processes, such as `fstat` and `fcntl`, working directories, and trees of parent and child processes
- Provide control over processes by allowing users to stop or resume them

Managing Processes by Using Process Commands (`/proc`)

You can display detailed technical information about processes or control active processes by using some of the process commands. For a list of some of the process commands, see Table 3, “Process Commands (`/proc`),” on page 34.

If a process becomes trapped in an endless loop, or if the process takes too long to execute, you might want to stop (kill) the process. For more information about stopping processes using the `kill` or the `pkill` command, see Chapter 2, “Managing System Processes”.

The `/proc` file system is a directory hierarchy that contains additional subdirectories for state information and control functions.

The `/proc` file system also provides an `xwatchpoint` facility that is used to remap read-and-write permissions on the individual pages of a process' address space. This facility has no restrictions and is MT-safe.

Debugging tools have been modified to use the `xwatchpoint` facility, which means that the entire `xwatchpoint` process is faster.

The following restrictions no longer apply when you set `xwatchpoints` by using the `dbx` debugging tool:

- Setting `xwatchpoints` on local variables on the stack due to SPARC based system register windows.

- Setting `xwatchpoints` on multithreaded processes.

For more information, see the `proc(4)` and `mdb(1)` man pages.

How to List Processes

Use the `ps` command to list all the processes on a system.

```
$ ps [-efc]
```

`ps`	Displays only the processes that are associated with your login session.
`-ef`	Displays full information about all the processes that are being executed on the system.
`-c`	Displays process scheduler information.

Example 9 Listing Processes

The following example shows output from the `ps` command when no options are used.

```
$ ps
   PID TTY      TIME COMD
  1664 pts/4    0:06 csh
  2081 pts/4    0:00 ps
```

The following example shows output from the `ps -ef` command. This output shows that the first process that is executed when the system boots is `sched` (the swapper) followed by the `init` process, `pageout`, and so on.

```
$ ps -ef
 UID   PID  PPID   C    STIME TTY         TIME CMD
    root     0     0   0 18:04:04 ?           0:15 sched
    root     5     0   0 18:04:03 ?           0:05 zpool-rpool
    root     1     0   0 18:04:05 ?           0:00 /sbin/init
    root     2     0   0 18:04:05 ?           0:00 pageout
    root     3     0   0 18:04:05 ?           2:52 fsflush
    root     6     0   0 18:04:05 ?           0:02 vmtasks
  daemon   739     1   0 19:03:58 ?           0:00 /usr/lib/nfs/nfs4cbd
    root     9     1   0 18:04:06 ?           0:14 /lib/svc/bin/svc.startd
    root    11     1   0 18:04:06 ?           0:45 /lib/svc/bin/svc.configd
  daemon   559     1   0 18:04:49 ?           0:00 /usr/sbin/rpcbind
  netcfg    47     1   0 18:04:19 ?           0:01 /lib/inet/netcfgd
   dladm    44     1   0 18:04:17 ?           0:00 /sbin/dlmgmtd
  netadm    51     1   0 18:04:22 ?           0:01 /lib/inet/ipmgmtd
```

```
    root   372   338   0 18:04:43 ?           0:00 /usr/lib/hal/hald-addon-cpufreq
    root    67     1   0 18:04:30 ?           0:02 /lib/inet/in.mpathd
    root   141     1   0 18:04:38 ?           0:00 /usr/lib/pfexecd
  netadm    89     1   0 18:04:31 ?           0:03 /lib/inet/nwamd
    root   602     1   0 18:04:50 ?           0:02 /usr/lib/inet/inetd start
    root   131     1   0 18:04:35 ?           0:01 /sbin/dhcpagent
  daemon   119     1   0 18:04:33 ?           0:00 /lib/crypto/kcfd
    root   333     1   0 18:04:41 ?           0:07 /usr/lib/hal/hald --daemon=yes
    root   370   338   0 18:04:43 ?           0:00 /usr/lib/hal/hald-addon-network-
discovery
    root   159     1   0 18:04:39 ?           0:00 /usr/lib/sysevent/syseventd
    root   236     1   0 18:04:40 ?           0:00 /usr/lib/ldoms/drd
    root   535     1   0 18:04:46 ?           0:09 /usr/sbin/nscd
    root   305     1   0 18:04:40 ?           0:00 /usr/lib/zones/zonestatd
    root   326     1   0 18:04:41 ?           0:03 /usr/lib/devfsadm/devfsadmd
    root   314     1   0 18:04:40 ?           0:00 /usr/lib/dbus-daemon --system
    .
  .
  .
```

▼ How to Display Information About Processes

1. Obtain the process ID of the process that you want to display more information about.

```
# pgrep process
```

The process ID is displayed in the first column of the output.

2. Display the process information.

```
# /usr/bin/pcommand PID
```

pcommand — The process command that you want to run. For a description of all the process commands, see Table 3, “Process Commands (/proc),” on page 34.

PID — Identifies the process ID.

Example 10 Displaying Information About Processes

The following example shows how to use process commands to display more information about a `cron` process.

```
# pgrep cron      Obtains the process ID for the cron process
```

```
4780
# pwdx 4780       Displays the current working directory for the cron process
4780:   /var/spool/cron/atjobs
# ptree 4780      Displays the process tree that contains the cron process
4780  /usr/sbin/cron
# pfiles 4780     Displays fstat and fcntl information
4780:   /usr/sbin/cron
  Current rlimit: 256 file descriptors
   0: S_IFCHR mode:0666 dev:290,0 ino:6815752 uid:0 gid:3 rdev:13,2
      O_RDONLY|O_LARGEFILE
      /devices/pseudo/mm@0:null
   1: S_IFREG mode:0600 dev:32,128 ino:42054 uid:0 gid:0 size:9771
      O_WRONLY|O_APPEND|O_CREAT|O_LARGEFILE
      /var/cron/log
   2: S_IFREG mode:0600 dev:32,128 ino:42054 uid:0 gid:0 size:9771
      O_WRONLY|O_APPEND|O_CREAT|O_LARGEFILE
      /var/cron/log
   3: S_IFIFO mode:0600 dev:32,128 ino:42049 uid:0 gid:0 size:0
      O_RDWR|O_LARGEFILE
      /etc/cron.d/FIFO
   4: S_IFIFO mode:0000 dev:293,0 ino:4630 uid:0 gid:0 size:0
      O_RDWR|O_NONBLOCK
   5: S_IFIFO mode:0000 dev:293,0 ino:4630 uid:0 gid:0 size:0
      O_RDWR
```

▼ How to Control Processes

1. Obtain the process ID of the process that you want to control.

```
# pgrep process
```

The process ID displayed in the first column of the output.

2. Use the appropriate process command to control the process.

```
# /usr/bin/pcommand PID
```

pcommand — The process command that you want to run. For a description of all the process commands, see Table 3, “Process Commands (/proc),” on page 34.

PID — Identifies the process ID.

3. Verify the process status.

```
# ps -ef | grep PID
```

Terminating a Process

You might need to stop (kill) a process that is in an endless loop, or stop a large job before it is completed. You can kill any process that you own. The system administrator can kill any process in the system except for those processes with process IDs of 0, 1, 2, 3, and 4. Killing these processes most likely will crash the system.

For more information, see the pgrep(1), pkill(1), and kill(1) man pages.

▼ How to Terminate a Process Using the pkill Command

1. **To terminate the process of another user, assume the root role.**

2. **Obtain the process ID for the process that you want to terminate.**

```
$ pgrep process
```

For example:

```
$ pgrep netscape
587
566
```

The process ID is displayed in the output.

Note - To obtain information about processes on a Sun Ray™system, use the following commands:

To list all user processes:

```
# ps -fu user
```

To locate a specific process owned by a user:

```
# ps -fu user | grep process
```

---

3. **Terminate the process.**

```
$ pkill [signal] PID
```

signal — When no signal is included in the pkill command-line syntax, the default signal that is used is –15 (SIGKILL). Using the –9 signal (SIGTERM) with the pkill command ensures that the process terminates promptly. However, the –9 signal should not be used to kill certain

processes such as a database process or an LDAP server process because data might be lost.

PID The name of the process to stop.

Tip - When using the `pkill` command to terminate a process, first try using the command by itself without including a signal option. If the process does not terminate after a few minutes, use the `pkill` command with the -9 signal.

---

4. **Verify that the process has been terminated.**

```
$ pgrep process
```

The process you terminated should no longer be listed in the output of the `pgrep` command.

How to Terminate a Process Using the `kill` Command

1. **To terminate the process of another user, assume the `root` role.**
2. **Obtain the process ID of the process that you want to terminate.**

```
# ps -fu user
```

where *user* is the owner of the process.

The process ID is displayed in the first column of the output.

3. **Terminate the process.**

```
# kill [signal-number] PID
```

signal When no signal is included in the `kill` command-line syntax, the default signal that is used is –15 (`SIGKILL`). Using the –9 signal (`SIGTERM`) with the `kill` command ensures that the process terminates promptly. However, the –9 signal should not be used to kill certain processes such as a database process or an LDAP server process because data might be lost.

PID Is the process ID of the process that you want to terminate.

Tip - When using the `kill` command to stop a process, first try using the command by itself, without including a signal option. Wait a few minutes to see if the process terminates before using the `kill` command with the -9 signal.

---

4. **Verify that the process has been terminated.**

```
$ ps
```

The process you terminated should no longer be listed in the output of the ps command.

Debugging a Process

The pargs command and the preap command improve process debugging. The pargs command prints the arguments and environment variables that are associated with a live process or core file. The preap command removes defunct (zombie) processes. A zombie process has not yet had its exit status claimed by its parent. These processes are generally harmless but can consume system resources if they are numerous. You can use the pargs and preap commands to examine any process that you have the privileges to examine. When you become an administrator, you can examine any process.

For information about using the preap command, see the preap(1) man page. For information about the using the pargs command, see the pargs(1) man page. Also, see the proc(1) man page.

EXAMPLE 11 Debugging a Process (pargs)

The pargs command is unable to display all the arguments that are passed to a process with the ps command. The following example shows how to use the pargs command in combination with the pgrep command to display all the arguments that are passed to a process.

```
# pargs `pgrep ttymon`
579: /usr/lib/saf/ttymon -g -h -p system-name console login:
-T sun -d /dev/console -l
argv[0]: /usr/lib/saf/ttymon
argv[1]: -g
argv[2]: -h
argv[3]: -p
argv[4]: system-name console login:
argv[5]: -T
argv[6]: sun
argv[7]: -d
argv[8]: /dev/console
argv[9]: -l
argv[10]: console
argv[11]: -m
argv[12]: ldterm,ttcompat
548: /usr/lib/saf/ttymon
argv[0]: /usr/lib/saf/ttymon
```

The following example shows how to use the `pargs -e` command to display the environment variables that are associated with a process.

```
$ pargs -e 6763
6763: tcsh
envp[0]: DISPLAY=:0.0
```

Displaying and Managing Process Class Information

You can configure the process scheduling classes on your system and the user priority range for the timesharing class.

The possible process scheduling classes are as follows:

- Fair share (`FSS`)
- Fixed (`FX`)
- System (`SYS`)
- Interactive (`IA`)
- Real-time (`RT`)
- Timesharing (`TS`)
  - The user-supplied priority ranges from -60 to +60.
  - The priority of a process is inherited from the parent process. This priority is referred to as the *user-mode priority*.
  - The system looks up the user-mode priority in the timesharing dispatch parameter table. Then, the system adds in any `nice` or `priocntl` (user-supplied) priority and ensures a 0–59 range to create a *global priority*.

Displaying Process Class Information

This section covers the following topics:

- "Displaying Process Priority Information" on page 42
- "Displaying the Global Priority of a Process" on page 43

Displaying Process Priority Information

You can use the `priocntl -l` command to display process scheduling classes and priority ranges.

```
$ priocntl -l
```

The following example shows output from the `priocntl -l` command.

```
# priocntl -l
CONFIGURED CLASSES
==================

SYS (System Class)

TS (Time Sharing)
        Configured TS User Priority Range: -60 through 60

FX (Fixed priority)
        Configured FX User Priority Range: 0 through 60

IA (Interactive)
        Configured IA User Priority Range: -60 through 60
```

Displaying the Global Priority of a Process

You can use the `ps` command to display the global priority of a process.

```
$ ps -ecl
```

The global priority is listed under the `PRI` column.

The following example shows `ps -ecl` command output. The values in the `PRI` column show the priority for each process.

```
$ ps -ecl
 F S    UID   PID  PPID  CLS PRI     ADDR     SZ    WCHAN TTY         TIME CMD
 1 T      0     0     0  SYS  96        ?      0          ?         0:11 sched
 1 S      0     5     0  SDC  99        ?      0        ? ?         0:01 zpool-rp
 0 S      0     1     0   TS  59        ?    688        ? ?         0:00 init
 1 S      0     2     0  SYS  98        ?      0        ? ?         0:00 pageout
 1 S      0     3     0  SYS  60        ?      0        ? ?         2:31 fsflush
 1 S      0     6     0  SDC  99        ?      0        ? ?         0:00 vmtasks
 0 S     16    56     1   TS  59        ?   1026        ? ?         0:01 ipmgmtd
 0 S      0     9     1   TS  59        ?   3480        ? ?         0:04 svc.star
 0 S      0    11     1   TS  59        ?   3480        ? ?         0:13 svc.conf
 0 S      0   162     1   TS  59        ?    533        ? ?         0:00 pfexecd
 0 S      0  1738  1730   TS  59        ?    817        ? pts/ 1       0:00 bash
 0 S      1   852     1   TS  59        ?    851        ? ?         0:17 rpcbind
 0 S     17    43     1   TS  59        ?   1096        ? ?         0:01 netcfgd
 0 S     15    47     1   TS  59        ?    765        ? ?         0:00 dlmgmtd
 0 S      0    68     1   TS  59        ?    694        ? ?         0:01 in.mpath
 0 S      1  1220     1   FX  60        ?    682        ? ?         0:00 nfs4cbd
 0 S     16    89     1   TS  59        ?   1673        ? ?         0:02 nwamd
```

```
0 S      0   146     1   TS  59        ?    629        ? ?         0:01 dhcpagen
0 S      1   129     1   TS  59        ?   1843        ? ?         0:00 kcfd
0 S      1  1215     1   FX  60        ?    738        ? ?         0:00 lockd
0 S      0   829   828   TS  59        ?    968        ? ?         0:00 hald-run
0 S      0   361     1   TS  59        ?   1081        ? ?         0:01 devfsadm
0 S      0   879     1   TS  59        ?   1166        ? ?         0:01 inetd
0 O 119764  1773   880   TS  59        ?    557          cons ole     0:00 ps
0 S      0   844   829   TS  59        ?    996        ? ?         0:00 hald-add
0 S      0   895   866   TS  59        ?    590        ? ?         0:00 ttymon
0 S      0   840     1   TS  59        ?    495        ? ?         0:00 cron
0 S      0   874     1   TS  59        ?    425        ? ?         0:00 utmpd
0 S      0  1724   956   TS  59        ?   2215        ? ?         0:00 sshd
0 S 119764   880     9   TS  59        ?    565        ? cons ole     0:00 csh
0 S      0   210     1   TS  59        ?   1622        ? ?         0:00 sysevent
0 S      0   279     1   TS  59        ?    472        ? ?         0:00 iscsid
0 S      1  1221     1   TS  59        ?   1349        ? ?         0:00 nfsmapid
1 S      0   374     0  SDC  99        ?      0        ? ?         0:00 zpool-us
0 S      0  1207     1   TS  59        ?   1063        ? ?         0:00 rmvolmgr
0 S      0   828     1   TS  59        ?   1776        ? ?         0:03 hald
0 S      0   853   829   TS  59        ?    896        ? ?         0:02 hald-add
0 S      0   373     1   TS  59        ?    985        ? ?         0:00 picld
0 S      0   299     1   TS  59        ?    836        ? ?         0:00 dbus-dae
0 S  12524  1730  1725   TS  59        ?    452        ? pts/ 1       0:00 csh
0 S      0   370     1   TS  59        ?    574        ? ?         0:00 powerd
0 S      0   264     1   FX  60        ?    637        ? ?         0:00 zonestat
0 S      0   866     9   TS  59        ?    555        ? ?         0:00 sac
0 S      0   851   829   TS  59        ?    998        ? ?         0:00 hald-add
0 S  12524  1725  1724   TS  59        ?   2732        ? ?         0:00 sshd
0 S      1  1211     1   TS  59        ?    783        ? ?         0:00 statd
0 S      0  1046     1   TS  59        ?   1770        ? ?         0:13 intrd
0 S      0   889     1   TS  59        ?   1063        ? ?         0:00 syslogd
0 S      0  1209     1   TS  59        ?    792        ? ?         0:00 in.ndpd
0 S      0  1188  1186   TS  59        ?    951        ? ?         0:15 automoun
0 S      0  1172   829   TS  59        ?    725        ? ?         0:00 hald-add
0 S      0  1186     1   TS  59        ?    692        ? ?         0:00 automoun
0 S    101  1739  1738   TS  59        ?    817        ? pts/ 1       0:00 bash
0 S      0  1199     1   TS  59        ?   1495        ? ?         0:02 sendmail
0 S      0   956     1   TS  59        ?   1729        ? ?         0:00 sshd
0 S     25  1192     1   TS  59        ?   1528        ? ?         0:00 sendmail
0 S      0   934     1   TS  59        ?   6897        ? ?         0:14 fmd
0 S      0  1131     1   TS  59        ?   1691        ? ?         0:07 nscd
0 S      1  1181     1   TS  59        ?    699        ? ?         0:00 ypbind
```

Managing Process Class Information Task Map

Use the following procedures to manage your process classes.

Task	Description	For Instructions
Designate a process priority.	Start a process with a designated priority by using the `priocntl -e -c command`.	"How to Designate a Process Priority" on page 45
Change scheduling parameters of a timesharing process.	Use the `priocntl -s -m` command to change scheduling parameters in a timesharing process.	"How to Change Scheduling Parameters of a Timesharing Process" on page 46
Change the class of a process.	Use the `priocntl -s -c` command to change the class of a process.	"How to Change the Class of a Process" on page 47
Change the priority of a process.	Use the `/usr/bin/nice` command with the appropriate options to lower or raise the priority of a process.	"Changing the Priority of a Process" on page 49

Changing the Scheduling Priority of Processes

The scheduling priority of a process is the priority assigned by the process scheduler, according to scheduling policies. The `dispadmin` command lists the default scheduling policies. For more information, see the `dispadmin`(1M) man page.

You can use the `priocntl` command to assign processes to a priority class and to manage process priorities as shown in the following procedure.

▼ How to Designate a Process Priority

1. **Assume the `root` role.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Start a process with a designated priority.**

   `#` `priocntl -e -c` *class* **`-m`** *user-limit* **`-p`** *PRI command-name*

   -e Executes the command.

`-c` *class*	Specifies the class within which to run the process. The valid classes are `TS` (timesharing), `RT` (real time), IA (interactive), FSS (fair share), and FX (fixed priority).
`-m` *user-limit*	Specifies the maximum amount you can raise or lower your priority, when you use the -poption with this option.
`-p` *PRI*	Enables you specify the relative priority in the RT class for a real-time thread. For a timesharing process, the `-p` option enables you to specify the user-supplied priority, which ranges from -60 to +60.
command-name	Specifies the name of the command that will be executed.

3. **Verify the process status.**

```
# ps -ecl | grep command-name
```

Example 12 Designating a Process Priority

The following example shows how to start the `find` command with the highest possible user-supplied priority.

```
# priocntl -e -c TS -m 60 -p 60 find . -name core -print
# ps -ecl | grep find
```

How to Change Scheduling Parameters of a Timesharing Process

1. **Assume the `root` role.**
   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Change the scheduling parameters of a running timesharing process.**

```
# priocntl -s -m user-limit [-p user-priority] -i ID type ID list
```

`-s`	Lets you set the upper limit on the user priority range and change the current priority.
`-m` *user-limit*	Specifies the maximum amount you can raise or lower the priority, when you use the `-p` option with this option.

`-p` *user-priority* — Allows you to designate a priority.

`-i` *ID type ID list* — Uses a combination of *ID type* and *ID list* to identify the process or processes. *ID type* specifies the type of ID, such as the process ID or the user ID. *ID list* identifies a list of process IDs or user IDs.

3. **Verify the process status.**

```
# ps -ecl | grep ID list
```

Example 13 Changing Scheduling Parameters of a Timesharing Process (`priocntl`)

The following example shows how to execute a command with a 500-millisecond time slice, a priority of 20 in the RT class, and a global priority of 120.

```
# priocntl -e -c RT -m 500 -p 20 myprog
# ps -ecl | grep myprog
```

▼ How to Change the Class of a Process

1. **(Optional) Assume the `root` role.**

Note - You must assume the root role or be working in a real-time shell to change a process from, or to, a real-time process. If, in the root role, you change a user process to the real-time class, the user cannot subsequently change the real-time scheduling parameters by using the `priocntl -s` command.

For more information, see "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

---

2. **Change the class of a process.**

```
# priocntl -s -c class -i ID type ID list
```

`-s` — Lets you set the upper limit on the user priority range and change the current priority.

`-c` *class* — Specifies the class, `TS` for time-sharing or `RT` for real-time, to which you are changing the process.

`-i` *ID type ID list* — Uses a combination of *ID type* and *ID list* to identify the process or processes. *ID type* specifies the type of ID, such as the process ID or user ID. *ID list* identifies a list of process IDs or user IDs.

3. **Verify the process status.**

   # ps -ecl | grep *ID list*

Example 14 Changing the Class of a Process

The following example shows how to change all the processes that belong to user `15249` to real-time processes.

```
# priocntl -s -c RT -i uid 15249
# ps -ecl | grep 15249
```

Changing the Priority of a Timesharing Process

The `nice` command is supported only for backward compatibility to previous releases. The `priocntl` command provides more flexibility in managing processes.

The priority of a process is determined by the policies of its scheduling class and by its *nice number*. Each timesharing process has a global priority. The global priority is calculated by adding the user-supplied priority, which can be influenced by the `nice` or `priocntl` commands, and the system-calculated priority.

The execution priority number of a process is assigned by the operating system. The priority number is determined by several factors, including the scheduling class of processes, its CPU time consumption, and in the case of a timesharing process, its `nice` number.

Each timesharing process starts with a default `nice` number, which it inherits from its parent process. The `nice` number is shown in the `NI` column of the `ps` report.

A user can lower the priority of a process by increasing its user-supplied priority. However, only an administrator can lower a `nice` number to increase the priority of a process. This restriction prevents users from increasing the priorities of their own processes, thereby monopolizing a greater share of the CPU.

The `nice` numbers range from 0 to +39, with 0 representing the highest priority. The default `nice` value for each timesharing process is 20. Two versions of the command are available: the standard version, `/usr/bin/nice`, and the C shell built-in command.

Changing the Priority of a Process

As a user, you can only lower the priority of a process. However,as an administrator, you can raise or lower the priority of a process.

- As a user, you can lower the priority of a command by increasing the `nice` number.

  The following `nice` command executes *command-name* with a lower priority by raising the nice number by 5 units.

  ```
  $ /usr/bin/nice -5 command-name
  ```

  In this command, the minus sign designates that what follows is an option. This command could also be specified as follows:

  ```
  $ /usr/bin/nice -n 5 command-name
  ```

  The following `nice` command lowers the priority of *command-name* by raising the nice number by the default increment of 10 units, but not beyond the maximum value of 39.

  ```
  $ /usr/bin/nice command-name
  ```

- As an administrator, you can raise or lower the priority of a command by changing the `nice` number.

  The following `nice` command raises the priority of *command-name* by lowering the nice number by 10 units. It is not lowered below the minimum value of 0.

  ```
  # /usr/bin/nice --10 command-name
  ```

  In this command, the first minus sign designates that what follows is an option. The second minus sign indicates a negative number.

  The following `nice` command lowers the priority of *command-name* by raising the nice number by 5 units. It does not exceed the maximum value of 39.

  ```
  # /usr/bin/nice -5 command-name
  ```

For more information, see the `nice(1)` man page.

Troubleshooting Problems With System Processes

Some common system process problems you might encounter are as follows:

- Several identical jobs that are owned by the same user. This problem might occur because of a running script that starts a lot of background jobs without waiting for any of the jobs to finish.
- A process that has accumulated a large amount of CPU time. You can identify this problem by checking the `TIME` field in the `ps` output. This value can indicate that the process is in an endless loop.
- A process that is running with a priority that is too high. Use the `ps -c` command to check the `CLS` field, which displays the scheduling class of each process. A process executing as a real-time (`RT`) process can monopolize the CPU. Or, look for a timesharing (`TS`) process with a high `nice` number. An administrator might have increased the priority of a process. The system administrator can lower the priority by using the `nice` command.
- A runaway process that progressively uses increasing amounts of CPU time. You can identify this problem by looking at the time when the process started (`STIME`) and by watching the cumulation of CPU time (`TIME`) for a while.

♦ ♦ ♦ CHAPTER 3

Monitoring System Performance

Achieving good performance from a computer or network is an important part of system administration. This chapter describes some factors that contribute to managing the performance of your computer systems. In addition, this chapter describes procedures for monitoring system performance by using the `vmstat`, `iostat`, `df`, and `sar` commands.

This chapter covers the following topics:

About Monitoring System Performance

System Performance Task	For More Information
Manage processes	Chapter 2, "Managing System Processes"
Monitor system performance	Chapter 3, "Monitoring System Performance"
Change tunable parameters	*Oracle Solaris 11.3 Tunable Parameters Reference Manual*
Manage system performance tasks	Chapter 2, "About Projects and Tasks" in *Administering Resource Management in Oracle Solaris 11.3*
Manage processes with FX and FS schedulers	Chapter 8, "About Fair Share Scheduler" in *Administering Resource Management in Oracle Solaris 11.3*

System Resources That Affect System Performance

The performance of a computer system depends on how the system uses and allocates its resources. Monitor the performance of your system regularly so that you know how it behaves under normal conditions.

The following system resources affect performance:

Central processing unit (CPU)	The CPU processes instructions by fetching instructions from memory and executing them.
Input/output (I/O) devices	I/O devices, for example network connections, transfer information in and out of a system. I/O devices also include terminals, keyboards, disk drives, and printers.
Memory	Physical (or main) memory is the amount of random access memory (RAM) on the system.

Chapter 3, “Monitoring System Performance” describes the tools that display statistics about the activity and performance of your system.

Manage Performance Using Oracle Enterprise Manager Ops Center

If you need to monitor, analyze, and improve performance of physical and virtual operating systems, servers, and storage devices in a large deployment, rather than just monitoring performance within individual systems, you can use the comprehensive system management solutions available in the Oracle Enterprise Manager Ops Center.

The monitoring feature in the Enterprise Manager Ops Center provides extensive information about the monitored operating systems and zones in a large deployment. You can use the information to evaluate performance, identify issues, and perform tuning. Analytics are available for the Oracle Solaris operating system, for Linux, and for OS virtualization technologies including Oracle Solaris Zones, Oracle VM Server for SPARC, and Oracle VM Server for x86 guests.

For information, see Oracle Enterprise Manager Ops Center 12c Release 2 library.

About Processes and System Activities

Some terms that are related to processes are:

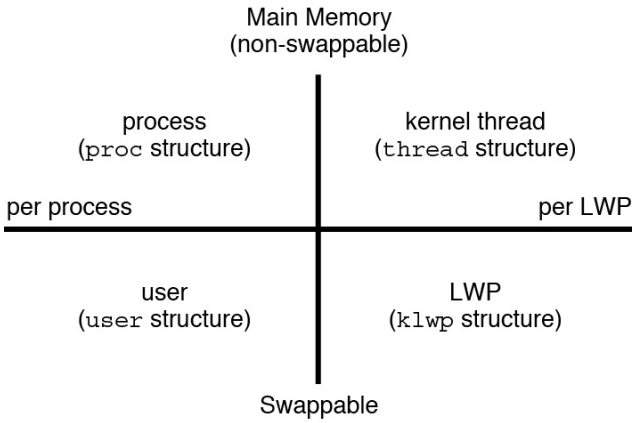
Process	Any system activity or job. Each time you boot a system, execute a command, or start an application, the system activates one or more processes.
Lightweight process (LWP)	A virtual CPU or execution resource. LWPs are scheduled by the kernel to use available CPU resources based on their scheduling class and priority. An LWP contains information that is swappable and a kernel thread that contains information that has to be in memory all the time.
Application thread	A series of instructions with a separate stack that can execute independently in the address space of a user. Application threads can be multiplexed on top of LWPs.

A process can consist of multiple LWPs and multiple application threads. The kernel schedules a kernel-thread structure, which is the scheduling entity in the Oracle Solaris environment. Various process structures are as follows:

`proc`	Contains information that pertains to the whole process and must be in main memory all the time
`kthread`	Contains information that pertains to one LWP and must always be in main memory
`user`	Contains the “per process” information that is swappable
`klwp`	Contains the “per LWP process” information that is swappable

The following figure illustrates the relationships among these process structures.

FIGURE 1 Relationships Among Process Structures



Most process resources are accessible to all the threads in the process. Almost all process virtual memory is shared. A change in shared data by one thread is available to the other threads in the process.

System Activities That are Monitored

While your computer is running, counters in the operating system are incremented to track various system activities.

The following system activities are tracked:

- Central processing unit (CPU) utilization
- Buffer usage
- Disk and tape input/output (I/O) activity
- Terminal device activity
- System call activity
- Context switching
- File access
- Queue activity
- Kernel tables

- Interprocess communication
- Paging
- Free memory and swap space
- Kernel memory allocation (KMA)

The Oracle Solaris software provides several tools to help you track how your system is performing.

TABLE 4 Performance Monitoring Commands

Command	Description	For More Information
`cpustat` and `cputrack` commands	Monitors performance of a system or a process using CPU performance counters.	`cpustat`(1M), `cputrack`(1)
`netstat` and `nfsstat` commands	Displays information about network performance.	`netstat`(1M), `nfsstat`(1M)
`ps` and `prstat` commands	Displays information about active processes.	Chapter 2, "Managing System Processes"
`sar` and `sadc` commands	Collects and reports on system activity data.	Chapter 3, "Monitoring System Performance"
`swap` command	Displays information about available swap space on your system.	"Managing ZFS Swap and Dump Devices" in *Managing ZFS File Systems in Oracle Solaris 11.3*
`vmstat` and `iostat` commands	Summarizes system activity data, such as virtual memory statistics, disk usage, and CPU activity.	Chapter 3, "Monitoring System Performance"
`kstat` and `mpstat` commands	Examines the available kernel statistics, or `kstats`, on the system and reports those statistics which match the criteria specified on the command line. The `mpstat` command reports processor statistics in tabular form.	`kstat`(1M), `mpstat`(1M)

Displaying System Performance Information

This section describes the tasks for monitoring and displaying system performance information.

Displaying Virtual Memory Statistics

You can use the `vmstat` command to report virtual memory statistics and information about system events such as CPU load, paging, number of context switches, device interrupts, and

system calls. The `vmstat` command can also display statistics on swapping, cache flushing, and interrupts.

TABLE 5 Output From the `vmstat` Command

Category	Field Name	Description
`kthr`		Reports the number of kernel threads in the following states
	`r`	The number of kernel threads in the dispatch queue
	`b`	The number of blocked kernel threads that are waiting for resources
	`w`	The number of swapped-out LWPs that are waiting for processing resources to finish
`memory`		Reports on usage of real memory and virtual memory
	`swap`	Available swap space
	`free`	Size of the free list
`page`		Reports on page faults and paging activity, in units per second
	`re`	Pages reclaimed
	`mf`	Minor faults and major faults
	`pi`	Kilobytes paged in
	`po`	Kilobytes paged out
	`fr`	Kilobytes freed
	`de`	Anticipated memory that is needed by recently swapped-in processes
	`sr`	Pages scanned by the `page` daemon not currently in use. If `sr` does not equal zero, the `page` daemon has been running.
`disk`		Reports the number of disk operations per second, showing data on up to four disks
`faults`		Reports the trap/interrupt rates per second
	`in`	Interrupts per second
	`sy`	System calls per second
	`cs`	CPU context switch rate
`cpu`		Reports on the use of CPU time
	`us`	User time
	`sy`	System time
	`id`	Idle time

To display virtual memory statistics, use the `vmstat` command with a time interval in seconds.

```
$ vmstat n
```

where *n* is the interval in seconds between reports.

The following example shows the `vmstat` display of statistics that were gathered at five-second intervals:

```
$ vmstat 5
kthr      memory            page            disk          faults      cpu
 r b w   swap  free  re  mf pi po fr de sr dd f0 s1 --   in   sy   cs us sy id
 0 0 0 863160 365680  0   3  1  0  0  0  0  0  0  0  0  406  378  209  1  0 99
 0 0 0 765640 208568  0  36  0  0  0  0  0  0  0  0  0  479 4445 1378  3  3 94
 0 0 0 765640 208568  0   0  0  0  0  0  0  0  0  0  0  423  214  235  0  0 100
 0 0 0 765712 208640  0   0  0  0  0  0  0  3  0  0  0  412  158  181  0  0 100
 0 0 0 765832 208760  0   0  0  0  0  0  0  0  0  0  0  402  157  179  0  0 100
 0 0 0 765832 208760  0   0  0  0  0  0  0  0  0  0  0  403  153  182  0  0 100
 0 0 0 765832 208760  0   0  0  0  0  0  0  0  0  0  0  402  168  177  0  0 100
 0 0 0 765832 208760  0   0  0  0  0  0  0  0  0  0  0  402  153  178  0  0 100
 0 0 0 765832 208760  0  18  0  0  0  0  0  0  0  0  0  407  165  186  0  0 100
```

For a more detailed description of this command, see the `vmstat(1M)` man page.

Displaying System Event Information

You can use the `vmstat -s` command to show how many system events have taken place since the last time the system was booted.

```
$ vmstat -s
        0 swap ins
        0 swap outs
        0 pages swapped in
        0 pages swapped out
   522586 total address trans. faults taken
    17006 page ins
       25 page outs
    23361 pages paged in
       28 pages paged out
    45594 total reclaims
    45592 reclaims from free list
        0 micro (hat) faults
   522586 minor (as) faults
    16189 major faults
    98241 copy-on-write faults
   137280 zero fill page faults
    45052 pages examined by the clock daemon
        0 revolutions of the clock hand
       26 pages freed by the clock daemon
     2857 forks
       78 vforks
     1647 execs
```

```
 34673885 cpu context switches
 65943468 device interrupts
   711250 traps
 63957605 system calls
  3523925 total name lookups (cache hits 99%)
    92590 user   cpu
    65952 system cpu
 16085832 idle   cpu
     7450 wait   cpu
```

Displaying Swapping Statistics

You can use the `vmstat -S` command to show swapping statistics.

```
$ vmstat -S
kthr      memory            page            disk          faults      cpu
 r b w   swap  free  si  so pi po fr de sr dd f0 s1 --   in   sy   cs us sy id
 0 0 0 862608 364792  0   0  1  0  0  0  0  0  0  0  0  406  394  213  1  0 99
```

The swapping statistics fields are described in the following list. For a description of the other fields, see Table 5, “Output From the `vmstat` Command,” on page 56.

`si` Average number of LWPs that are swapped per second

`so` Number of whole processes that are swapped out

Note - The `vmstat` command truncates the output of `si` and `so` fields. Use the `sar` command to display a more accurate accounting of swap statistics.

Displaying Interrupts Per Device

You can use the `vmstat -i` command to show the number of interrupts per device.

The following example shows output from the `vmstat -i` command.

```
$ vmstat -i
interrupt         total     rate
--------------------------------
clock          52163269      100
esp0            2600077        4
zsc0              25341        0
```

```
zsc1              48917        0
cgsixc0             459        0
lec0             400882        0
fdc0                 14        0
bppc0                 0        0
audiocs0              0        0
-------------------------------
Total          55238959      105
```

Displaying Disk Utilization Information

You can use the `iostat` command to report statistics about disk input and output, and to produce measures of throughput, utilization, queue lengths, transaction rates, and service time. For a detailed description of this command, see the `iostat(1M)` man page.

Displaying Disk Utilization Information Using the `iostat` Command

You can display disk utilization information by using the `iostat` command with a time interval in seconds.

```
$ iostat 5
     tty          fd0           sd3          nfs1         nfs31          cpu
tin tout kps tps serv  kps tps serv  kps tps serv  kps tps serv  us sy wt id
  0    1   0   0  410    3   0   29    0   0    9    3   0   47   4  2  0 94
```

The first line of output shows the statistics since the last time the system was booted. Each subsequent line shows the interval statistics. The default is to show statistics for the terminal (`tty`), disks (`fd` and `sd`), and CPU (`cpu`).

The following example shows disk statistics that were gathered every five seconds.

```
$ iostat 5
tty        sd0           sd6           nfs1         nfs49          cpu
tin tout kps tps serv  kps tps serv  kps tps serv  kps tps serv  us sy wt id
 0    0   1   0   49    0   0    0    0   0    0    0   0   15   0  0  0 100
 0   47   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
 0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
 0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
 0   16  44   6  132    0   0    0    0   0    0    0   0    0   0  0  1 99
 0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
 0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
 0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
```

```
0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
0   16   3   1   23    0   0    0    0   0    0    0   0    0   0  0  1 99
0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
0   16   0   0    0    0   0    0    0   0    0    0   0    0   0  0  0 100
```

The following table describes the fields in the output of the `iostat` *n* command.

Device Type	Field Name	Description
Terminal	`tin`	Number of characters in the terminal input queue
	`tout`	Number of characters in the terminal output queue
Disk	`bps`	Blocks per second
	`tps`	Transactions per second
	`serv`	Average service time, in milliseconds
CPU	`us`	In user mode
	`sy`	In system mode
	`wt`	Waiting for I/O
	`id`	Idle

Displaying Extended Disk Statistics

You can use the `iostat &minus;xt` command to display extended disk statistics.

```
$ iostat &minus;xt
device     r/s    w/s   kr/s   kw/s wait actv wsvc_t asvc_t  %w  %b  tin tout
blkdev0    0.0    0.0    0.0    0.0  0.0  0.0    0.0    0.0   0   0    0    1
sd0        0.1   19.3    1.4   92.4  0.0  0.0    0.2    1.6   0   1
sd1        0.0    0.0    0.0    0.0  0.0  0.0    0.0    0.0   0   0
nfs9       0.0    0.0    0.0    0.0  0.0  0.0    0.0    1.0   0   0
nfs10      0.0    0.0    0.0    0.0  0.0  0.0    0.0    7.6   0   0
nfs11      0.0    0.0    0.0    0.0  0.0  0.0    0.0   15.6   0   0
nfs12      0.3    0.0    1.9    0.0  0.0  0.0    0.0   30.5   0   1
```

The `iostat &minus;xt` command displays a line of output for each disk. The output fields are as follows:

`r/s` Reads per second

`w/s` Writes per second

`kr/s`	Kilobytes read per second
`kw/s`	Kilobytes written per second
`wait`	Average number of transactions that are waiting for service (queue length)
`actv`	Average number of transactions that are actively being serviced
`svc_t`	Average service time, in milliseconds
`%w`	Percentage of time that the queue is not empty
`%b`	Percentage of time that the disk is busy

Displaying Disk Space Statistics

You can use the `df` command to show the amount of free disk space on each mounted disk. The *usable* disk space that is reported by `df` reflects only 90 percent of full capacity because the reporting statistics allows for 10 percent above the total available space. This *head room* normally stays empty for better performance.

The percentage of disk space actually reported by the `df` command is used space divided by usable space.

If the file system exceeds 90 percent capacity, you can transfer files to a disk that is not as full by using the `cp` command. Alternately, you can transfer files to a tape by using the `tar` or `cpio` commands or you can remove the files.

You can use the `df -k` command to display disk space information in kilobytes.

```
$ df -k
Filesystem            kbytes    used   avail capacity  Mounted on
/dev/dsk/c0t3d0s0     192807   40231  133296    24%    /
```

EXAMPLE 15 Displaying File System Information

The following example shows the output from the `df -k` command on a SPARC based system.

```
$ df -k
Filesystem           1024-blocks        Used   Available Capacity  Mounted on
```

```
rpool/ROOT/solaris-161   191987712     6004395   140577816     5%    /
/devices                         0           0           0     0%    /devices
/dev                             0           0           0     0%    /dev
ctfs                             0           0           0     0%    /system/contract
proc                             0           0           0     0%    /proc
mnttab                           0           0           0     0%    /etc/mnttab
swap                       4184236         496     4183740     1%    /system/volatile
objfs                            0           0           0     0%    /system/object
sharefs                          0           0           0     0%    /etc/dfs/sharetab
/usr/lib/libc/libc_hwcap1.so.1   146582211     6004395   140577816     5%    /lib/
libc.so.1
fd                               0           0           0     0%    /dev/fd
swap                       4183784          60     4183724     1%    /tmp
rpool/export             191987712          35   140577816     1%    /export
rpool/export/home        191987712          32   140577816     1%    /export/home
rpool/export/home/123   191987712    13108813   140577816     9%    /export/home/123
rpool/export/repo        191987712    11187204   140577816     8%    /export/repo
rpool/export/repo2010_11   191987712          31   140577816     1%    /export/
repo2010_11
rpool                    191987712     5238974   140577816     4%    /rpool
/export/home/123         153686630    13108813   140577816     9%    /home/123
```

The output fields of the `df -k` command are as follows:

`1024-blocks` Total size of usable space in the file system

`Used` Amount of space used

`Available` Amount of space available for use

`Capacity` Amount of space used, as a percentage of the total capacity

`Mounted on` Mount point

EXAMPLE 16 Displaying File System Information by Using the `df` Command Without Any Options

The following example shows a list of all the mounted file systems, when the `df` command is used without any options or operands.

```
$ df
/                  (rpool/ROOT/solaris):100715496 blocks 100715496 files
/devices           (/devices          ):       0 blocks        0 files
/dev               (/dev              ):       0 blocks        0 files
/system/contract   (ctfs             ):       0 blocks 2147483601 files
/proc              (proc             ):       0 blocks    29946 files
/etc/mnttab        (mnttab           ):       0 blocks        0 files
```

```
/system/volatile   (swap              ):42257568 blocks  2276112 files
/system/object     (objfs             ):       0 blocks 2147483441 files
/etc/dfs/sharetab  (sharefs           ):       0 blocks 2147483646 files
/dev/fd            (fd                ):       0 blocks        0 files
/tmp               (swap              ):42257568 blocks  2276112 files
/export            (rpool/export      ):100715496 blocks 100715496 files
/export/home       (rpool/export/home ):100715496 blocks 100715496 files
/export/home/admin (rpool/export/home/admin):100715496 blocks 100715496 files
/rpool             (rpool             ):100715496 blocks 100715496 files
/export/repo2010_11(rpool/export/repo2010_11):281155639 blocks 281155639 files
/rpool             (rpool             ):281155639 blocks 281155639 files
```

For a detailed description of this command, see the `df`(1M) man page.

Displaying Data Analytics Accelerator Statistics

The `daxstat` command reports the utilization and performance statistics for Data Analytics Accelerator (DAX) on systems that have the SPARC M7, SPARC M8, SPARC T7, or SPARC T8 chip. To use the `daxstat` command, you should have the appropriate rights profile. This command reports DAX statistics per-DAX, per-CPU, and per-queue in a tabular form. The first table summarizes all activity since boot. Each subsequent table summarizes the activity for the preceding interval. The values are reported as rates (events per second), unless mentioned otherwise.

The `daxstat` command has the following syntax:

```
/usr/bin/daxstat [[-T u | d] [-c processor_id] | [-d dax_id [-q queue_id]]] \
        | [-[x]d dax_id]] [interval [count]]

/usr/bin/daxstat -a [[-T u | d] [-c] | [-d [-q ]]] [-[x]d]] [interval [count]]
```

The following attributes are supported by the `daxstat` command.

`-a` The output is aggregated into a single value for all the CPUs, queues, and DAX units. Do not enter any *processor_id*, *dax_id*, or *queue_id* with this option.

`-c` Displays CPU statistics for specified CPUs.

`-d` Displays DAX statistics for specified DAX units.

`-q` Displays queue statistics for specified queues in specified DAX units.

`-x` Displays per-dax extended statistics for specified DAX units. This option is only valid when used with the `-d` option.

`-T u|d` Prints a time stamp before each report, in either standard date format, `d`, or the internal representation of time, `u`. For more information, see the `time(2)` and `date(1)` man pages.

interval Reports once each *interval* second.

count Prints only *count* reports.

EXAMPLE 17 Using the `daxstat` Command to Display per-DAX Statistics

The following example shows DAX statistics over a three-second interval in two reports.

```
$ daxstat -ad 3 2
DAX    commands fallbacks    input    output %busy
ALL      201757    194975    74.0M      0.0M     0
ALL       53388     52066     9.0G     31.0M     0
```

The output fields of the `daxstat` command for statistics per-DAX are as follows:

`DAX` DAX ID

`commands` Number of commands completed by DAX

`fallbacks` Number of commands completed by the software but not completed by DAX

`input` Total input processed by DAX in megabytes per second (M) or gigabytes per second (G)

`output` Total output produced by DAX in megabytes per second (M) or gigabytes per second (G)

`%busy` Percentage of DAX cycles spent processing a command

EXAMPLE 18 Using the `daxstat` Command to Display per-CPU Statistics

The following example shows DAX statistics for CPUs `0` and `1` in one report.

```
$ daxstat -c 0-1
CPU      calls       time    success       fail
  0     129894  229452150     129894          0
  1     129073  227907405     129073         10
```

The output fields of the `daxstat` command for DAX statistics per-CPU are as follows:

`CPU`	CPU ID
`calls`	Number of `dax_submit` fast trap calls
`time`	Total kernel and hypervisor time in *n* seconds since boot, spent submitting DAX commands,
`success`	Number of `ccb_submit` hyper-calls that returned `success`
`fail`	Number of `ccb_submit` hyper-calls that returned `fail`

EXAMPLE 19 Using the `daxstat` Command to Display per-queue Statistics

The following example shows DAX statistics for queues `0-3` in DAX unit `4`.

```
$ daxstat -d 4 -q 0-3
DAX   QUEUE    commands
  4       0         105
          1         196
          2         496
          3         196
```

where `QUEUE` is the queue ID.

For more information about the `daxstat` command, see the `daxstat(1M)` man page.

For more information about DAX, see "Breaking New Ground with Software in Silicon site.

Displaying DAX Information

You can use the `daxinfo` command to display the static configuration of DAX hardware available on systems that have the SPARC M7, SPARC M8, SPARC T7, or SPARC T8 chip. Information available includes DAX version, DAX operation codes, and the number of DAX instances on the system.

EXAMPLE 20 Displaying DAX Information

This example shows how to display information related to DAX by using the `daxinfo` command.

```
$ daxinfo
Version: DAX1
Opcodes: Extract Scan Select Translate
Enabled: 6
Disabled:0
```

where `Version` is the DAX version, `Opcodes` is the list of DAX operation codes that are supported, `Enabled` is the number of available DAX instances, and `Disabled` is the number of DAX instances with hardware error.

To display some of the selected fields, use `-o` and `-p` options with the `daxinfo` command as shown in the following example:

```
$ daxinfo -p -o version,enabled
DAX2:8
```

where `-p` displays the output in machine-readable format.

For more information, see the `daxinfo`(1M) man page.

Monitoring System Activities

This section describes how to monitor system activities by using the `sar` command.

Monitor System Activities Using `sar` Command

You can use the `sar` command to perform the following tasks:

- Organize and view data about system activity.
- Access system activity data on a special request basis.
- Generate automatic reports to measure and monitor system performance as well as special request reports to pinpoint specific performance problems. For information about how to set up the `sar` command to run on your system as well as a description of these tools, see "Collecting System Activity Data Automatically" on page 84.

For a detailed description of this command, see the `sar`(1) man page.

Checking File Access

You can display file access operation statistics with the `sar -a` command.

```
$ sar -a
SunOS t2k-brm-24 5.10 Generic_144500-10 sun4v    ...
00:00:00  iget/s namei/s dirbk/s
01:00:00       0       3       0
02:00:00       0       3       0
03:00:00       0       3       0
04:00:00       0       3       0
05:00:00       0       3       0
06:00:00       0       3       0
07:00:00       0       3       0
08:00:00       0       3       0
08:20:01       0       3       0
08:40:00       0       3       0
09:00:00       0       3       0
09:20:01       0      10       0
09:40:01       0       1       0
10:00:02       0       5       0

Average        0       4       0
```

The operating system routines that are reported by the `sar -a` command are as follows:

`iget/s` — The number of requests made for inodes that were not in the directory name look-up cache (DNLC).

`namei/s` — The number of file system path searches per second. If `namei` does not find a directory name in the DNLC, it calls `iget` to get the inode for either a file or directory. Hence, most `igets` are the result of DNLC misses.

`dirbk/s` — The number of directory block reads issued per second.

The larger the reported values for these operating system routines, the more time the kernel is spending to access user files. The amount of time reflects how heavily programs and applications are using the file systems. The `-a` option is helpful to view whether an application is disk-dependent.

Checking Buffer Activity

You can display buffer activity statistics with the `sar -b` command.

The buffer is used to cache metadata. Metadata includes inodes, cylinder group blocks, and indirect blocks.

```
$ sar -b
00:00:00 bread/s lread/s %rcache bwrit/s lwrit/s %wcache pread/s pwrit/s
01:00:00       0       0     100       0       0      55       0       0
```

The following table describes the buffer activities that are displayed by the `-b` option.

Field Name	Description
`bread/s`	Average number of reads per second that are submitted to the buffer cache from the disk
`lread/s`	Average number of logical reads per second from the buffer cache
`%rcache`	Fraction of logical reads that are found in the buffer cache (100 % minus the ratio of `bread/s` to `lread/s`)
`bwrit/s`	Average number of physical blocks (512 bytes) that are written from the buffer cache to disk per second
`lwrit/s`	Average number of logical writes to the buffer cache per second
`%wcache`	Fraction of logical writes that are found in the buffer cache (100 % minus the ratio of `bwrit/s` to `lwrit/s`)
`pread/s`	Average number of physical reads per second that use character device interfaces
`pwrit/s`	Average number of physical write requests per second that use character device interfaces

The most important entries are the cache hit ratios `%rcache` and `%wcache`. These entries measure the effectiveness of system buffering. If `%rcache` falls below 90 percent or if `%wcache` falls below 65 percent, you might be able to improve performance by increasing the buffer space.

EXAMPLE 21 Checking Buffer Activity

The following example of `sar -b` command output shows that the `%rcache` and `%wcache` buffers are not causing any slowdowns. All the data is within acceptable limits.

```
$ sar -b
SunOS t2k-brm-24 5.10 Generic_144500-10 sun4v    ...
00:00:04 bread/s lread/s %rcache bwrit/s lwrit/s %wcache pread/s pwrit/s
01:00:00       0       0     100       0       0      94       0       0
02:00:01       0       0     100       0       0      94       0       0
03:00:00       0       0     100       0       0      92       0       0
04:00:00       0       1     100       0       1      94       0       0
05:00:00       0       0     100       0       0      93       0       0
06:00:00       0       0     100       0       0      93       0       0
07:00:00       0       0     100       0       0      93       0       0
08:00:00       0       0     100       0       0      93       0       0
```

```
08:20:00       0       1     100       0       1      94       0       0
08:40:01       0       1     100       0       1      93       0       0
09:00:00       0       1     100       0       1      93       0       0
09:20:00       0       1     100       0       1      93       0       0
09:40:00       0       2     100       0       1      89       0       0
10:00:00       0       9     100       0       5      92       0       0
10:20:00       0       0     100       0       0      68       0       0
10:40:00       0       1      98       0       1      70       0       0
11:00:00       0       1     100       0       1      75       0       0

Average        0       1     100       0       1      91       0       0
```

Checking System Call Statistics

You can display system call statistics by using the `sar -c` command.

```
$ sar -c
00:00:00 scall/s sread/s swrit/s  fork/s  exec/s rchar/s wchar/s
01:00:00      38       2       2    0.00    0.00     149     120
```

The following list describes the system call categories that are reported by the `-c` option. Typically, reads and writes account for about half of the total system calls. However, the percentage varies greatly with the activities that are being performed by the system.

`scall/s` — The number of all types of system calls per second, which is generally about 30 per second on a system with four to six users.

`sread/s` — The number of `read` system calls per second.

`swrit/s` — The number of `write` system calls per second.

`fork/s` — The number of `fork` system calls per second, which is about 0.5 per second on a system with four to six users. This number increases if shell scripts are running.

`exec/s` — The number of `exec` system calls per second. If `exec/s` divided by `fork/s` is greater than 3, look for inefficient `PATH` variables.

`rchar/s` — The number of characters (bytes) transferred by `read` system calls per second.

`wchar/s` — The number of characters (bytes) transferred by `write` system calls per second.

EXAMPLE 22 Checking System Call Statistics

The following example shows output from the `sar -c` command.

```
$ sar -c
SunOS balmy 5.10 Generic_144500-10 sun4v ...
00:00:04 scall/s sread/s swrit/s  fork/s  exec/s rchar/s wchar/s
01:00:00      89      14       9    0.01    0.00    2906    2394
02:00:01      89      14       9    0.01    0.00    2905    2393
03:00:00      89      14       9    0.01    0.00    2908    2393
04:00:00      90      14       9    0.01    0.00    2912    2393
05:00:00      89      14       9    0.01    0.00    2905    2393
06:00:00      89      14       9    0.01    0.00    2905    2393
07:00:00      89      14       9    0.01    0.00    2905    2393
08:00:00      89      14       9    0.01    0.00    2906    2393
08:20:00      90      14       9    0.01    0.01    2914    2395
08:40:01      90      14       9    0.01    0.00    2914    2396
09:00:00      90      14       9    0.01    0.01    2915    2396
09:20:00      90      14       9    0.01    0.01    2915    2396
09:40:00     880     207     156    0.08    0.08   26671    9290
10:00:00    2020     530     322    0.14    0.13   57675   36393
10:20:00     853     129      75    0.02    0.01   10500    8594
10:40:00    2061     524     450    0.08    0.08  579217  567072
11:00:00    1658     404     350    0.07    0.06 1152916 1144203

Average      302      66      49    0.02    0.01   57842   55544
```

Checking Disk Activity

You can display disk activity statistics with the `sar -d` command.

```
$ sar -d
00:00:00   device        %busy   avque   r+w/s  blks/s  avwait  avserv
```

The output from the `-d` option is as follows:

`device` Name of the disk device that is being monitored.

`%busy` Portion of time the device was busy servicing a transfer request.

`avque` Average number of requests during the time the device was busy servicing a transfer request.

`r+w/s` Number of read-and-write transfers to the device, per second.

`blks/s` Number of 512-byte blocks that are transferred to the device, per second.

`avwait` Average time, in milliseconds, that transfer requests wait in the queue. This time is measured only when the queue is occupied.

`avserv` Average time, in milliseconds, for a transfer request to be completed by the device. For disks, this value includes seek times, rotational latency times, and data transfer times.

EXAMPLE 23 Checking Disk Activity

The following example illustrates the output from the `sar -d` command.

```
$ sar -d
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
12:36:32   device        %busy   avque   r+w/s  blks/s  avwait  avserv

12:40:01   dad1             15     0.7      26     399    18.1    10.0
           dad1,a           15     0.7      26     398    18.1    10.0
           dad1,b            0     0.0       0       1     1.0     3.0
           dad1,c            0     0.0       0       0     0.0     0.0
           dad1,h            0     0.0       0       0     0.0     6.0
           fd0               0     0.0       0       0     0.0     0.0
           nfs1              0     0.0       0       0     0.0     0.0
           nfs2              1     0.0       1      12     0.0    13.2
           nfs3              0     0.0       0       2     0.0     1.9
           nfs4              0     0.0       0       0     0.0     7.0
           nfs5              0     0.0       0       0     0.0    57.1
           nfs6              1     0.0       6     125     4.3     3.2
           nfs7              0     0.0       0       0     0.0     6.0
           sd1               0     0.0       0       0     0.0     5.4
           ohci0,bu          0     0.0       0       0     0.0     0.0
           ohci0,ct          0     0.0       0       0     0.0     0.0
           ohci0,in          0     0.0       7       0     0.0     0.0
           ohci0,is          0     0.0       0       0     0.0     0.0
           ohci0,to          0     0.0       7       0     0.0     0.0
```

Note that queue lengths and wait times are measured when something is in the queue. If `%busy` is small, large queues and service times probably represent the periodic efforts by the system to ensure that altered blocks are promptly written to the disk.

Checking Page-Out and Memory

You can use the `sar -g` command to display page-out and memory freeing activities in averages.

```
$ sar -g
```

```
00:00:00  pgout/s ppgout/s pgfree/s pgscan/s %ufs_ipf
01:00:00     0.00     0.00     0.00     0.00     0.00
```

The output displayed by the `sar -g` command is a good indicator of whether more memory might be needed. Use the `ps -elf` command to show the number of cycles that are used by the `page` daemon. A high number of cycles, combined with high values for the `pgfree/s` and `pgscan/s` fields, indicates a memory shortage.

The `sar -g` command also shows whether inodes are being recycled too quickly and causing a loss of reusable pages.

The output from the `-g` option is as follows:

`pgout/s` The number of page-out requests per second.

`ppgout/s` The actual number of pages that are paged-out per second. A single page-out request might involve paging-out multiple pages.

`pgfree/s` The number of pages per second that are placed on the free list.

`pgscan/s` The number of pages per second that are scanned by the `page` daemon. If this value is high, the `page` daemon is spending a lot of time checking for free memory. This situation implies that more memory is needed.

`%ufs_ipf` The percentage of `ufs` inodes taken off the free list by `iget` that had reusable pages associated with them. These pages are flushed and cannot be reclaimed by processes. Thus, this field represents the percentage of `igets` with page flushes. A high value indicates that the free list of inodes is page-bound, and that the number of `ufs` inodes need to be increased.

EXAMPLE 24 Checking Page-Out and Memory

The following example shows output from the `sar -g` command.

```
$ sar -g
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:00  pgout/s ppgout/s pgfree/s pgscan/s %ufs_ipf
01:00:00     0.00     0.00     0.00     0.00     0.00
02:00:00     0.01     0.01     0.01     0.00     0.00
03:00:00     0.00     0.00     0.00     0.00     0.00
04:00:00     0.00     0.00     0.00     0.00     0.00
05:00:00     0.00     0.00     0.00     0.00     0.00
06:00:00     0.00     0.00     0.00     0.00     0.00
```

```
07:00:00     0.00     0.00     0.00     0.00     0.00
08:00:00     0.00     0.00     0.00     0.00     0.00
08:20:01     0.00     0.00     0.00     0.00     0.00
08:40:00     0.00     0.00     0.00     0.00     0.00
09:00:00     0.00     0.00     0.00     0.00     0.00
09:20:01     0.05     0.52     1.62    10.16     0.00
09:40:01     0.03     0.44     1.47     4.77     0.00
10:00:02     0.13     2.00     4.38    12.28     0.00
10:20:03     0.37     4.68    12.26    33.80     0.00

Average      0.02     0.25     0.64     1.97     0.00
```

Checking Kernel Memory Allocation

The Kernel Memory Allocation (KMA) allows a kernel subsystem to allocate and free memory as needed.

Rather than statically allocating the maximum amount of memory that might be needed under peak load, the KMA divides requests for memory into three categories:

- Small (less than 256 bytes)
- Large (512 bytes to 4 KB)
- Oversized (greater than 4 KB)

The KMA keeps two pools of memory to satisfy small requests and large requests. The oversized requests are satisfied by allocating memory from the system page allocator.

The `sar -k` command is useful if you are checking a system that is being used to write drivers or STREAMS that use KMA resources. Any driver or module that uses KMA resources but does not specifically return the resources before it exits, can create a memory leak. A memory leak causes the amount of memory that is allocated by KMA to increase over time. Thus, if the `alloc` fields of the `sar -k` command increase steadily over time, there might be a memory leak. Another indication of a memory leak is failed requests. If this problem occurs, a memory leak has probably caused KMA to be unable to reserve and allocate memory.

If it appears that a memory leak has occurred, you should check any drivers or STREAMS that might have requested memory from KMA and not returned it.

You can use the `sar -k` command to report on activities of the Kernel Memory Allocator (KMA).

```
$ sar -k
00:00:00 sml_mem   alloc  fail  lg_mem   alloc   fail  ovsz_alloc  fail
01:00:00 2523136 1866512     0 18939904 14762364    0      360448     0
02:00:02 2523136 1861724     0 18939904 14778748    0      360448     0
```

The output from the `-k` option is as follows:

`sml_mem` The amount of memory in bytes that the KMA has available in the small memory request pool. In this pool, a small request is less than 256 bytes.

`alloc` The amount of memory in bytes that the KMA has allocated from its small memory request pool to small memory requests.

`fail` The number of requests for small amounts of memory that failed.

`lg_mem` The amount of memory in bytes that the KMA has available in the large memory request pool. In this pool, a large request is from 512 bytes to 4 KB.

`alloc` The amount of memory in bytes that the KMA has allocated from its large memory request pool to large memory requests.

`fail` The number of failed requests for large amounts of memory.

`ovsz_alloc` The amount of memory that is allocated for oversized requests, which are requests that are greater than 4 KB. These requests are satisfied by the page allocator. Thus, there is no pool.

`fail` The number of failed requests for oversized amounts of memory.

EXAMPLE 25 Checking Kernel Memory Allocation

The following example shows an abbreviated output from the `sar -k` command.

```
$ sar -k
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:04 sml_mem   alloc  fail  lg_mem   alloc  fail  ovsz_alloc  fail
01:00:00 6119744 4852865     0 60243968 54334808   156     9666560     0
02:00:01 6119744 4853057     0 60243968 54336088   156     9666560     0
03:00:00 6119744 4853297     0 60243968 54335760   156     9666560     0
04:00:00 6119744 4857673     0 60252160 54375280   156     9666560     0
05:00:00 6119744 4858097     0 60252160 54376240   156     9666560     0
06:00:00 6119744 4858289     0 60252160 54375608   156     9666560     0
07:00:00 6119744 4858793     0 60252160 54442424   156     9666560     0
08:00:00 6119744 4858985     0 60252160 54474552   156     9666560     0
08:20:00 6119744 4858169     0 60252160 54377400   156     9666560     0
08:40:01 6119744 4857345     0 60252160 54376880   156     9666560     0
09:00:00 6119744 4859433     0 60252160 54539752   156     9666560     0
09:20:00 6119744 4858633     0 60252160 54410920   156     9666560     0
09:40:00 6127936 5262064     0 60530688 55619816   156     9666560     0
```

```
10:00:00 6545728 5823137     0 62996480 58391136   156     9666560     0
10:20:00 6545728 5758997     0 62996480 57907400   156     9666560     0
10:40:00 6734144 6035759     0 64389120 59743064   156    10493952     0
11:00:00 6996288 6394872     0 65437696 60935936   156    10493952     0

Average  6258044 5150556     0 61138340 55609004   156     9763900     0
```

Checking Interprocess Communication

You can use the `sar -m` command to report interprocess communication activities.

```
$ sar -m
00:00:00   msg/s  sema/s
01:00:00    0.00    0.00
```

These figures are usually zero (0.00), unless you are running applications that use messages or semaphores.

The output from the `-m` option is as follows:

`msg/s` The number of message operations (`send` and `receive`) per second

`sema/s` The number of semaphore operations per second

The following abbreviated example shows output from the `sar -m` command.

```
$ sar -m
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:00   msg/s  sema/s
01:00:00    0.00    0.00
02:00:02    0.00    0.00
03:00:00    0.00    0.00
04:00:00    0.00    0.00
05:00:01    0.00    0.00
06:00:00    0.00    0.00

Average     0.00    0.00
```

Checking Page-In Activity

You can use the `sar -p` command to report page-in activity, which includes protection and translation faults.

```
$ sar -p
```

```
00:00:00  atch/s  pgin/s ppgin/s  pflt/s  vflt/s slock/s
01:00:00    0.07    0.00    0.00    0.21    0.39    0.00
```

The following list describes the reported statistics from the -p option.

`atch/s` The number of page faults per second that are satisfied by reclaiming a page currently in memory (attaches per second). Instances include reclaiming an invalid page from the free list and sharing a page of text that is currently being used by another process. An example is two or more processes that are accessing the same program text.

`pgin/s` The number of times per second that file systems receive page-in requests.

`ppgin/s` The number of pages paged in per second. A single page-in request, such as a soft-lock request (see `slock/s`) or a large block size, might involve paging-in multiple pages.

`pflt/s` The number of page faults from protection errors. Instances of protection faults indicate illegal access to a page and copy-on-writes. Generally, this number consists primarily of copy-on-writes.

`vflt/s` The number of address translation page faults per second. These faults are known as validity faults, faults occur when a valid process table entry does not exist for a given virtual address.

`slock/s` The number of faults per second caused by software lock requests that require physical I/O. An example of the occurrence of a soft-lock request is the transfer of data from a disk to memory. The system locks the page that is to receive the data so that the page cannot be claimed and used by another process.

EXAMPLE 26 Monitoring Page-In Activity

The following example shows output from the `sar -p` command.

```
$ sar -p
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:04  atch/s  pgin/s ppgin/s  pflt/s  vflt/s slock/s
01:00:00    0.09    0.00    0.00    0.78    2.02    0.00
02:00:01    0.08    0.00    0.00    0.78    2.02    0.00
03:00:00    0.09    0.00    0.00    0.81    2.07    0.00
04:00:00    0.11    0.01    0.01    0.86    2.18    0.00
05:00:00    0.08    0.00    0.00    0.78    2.02    0.00
06:00:00    0.09    0.00    0.00    0.78    2.02    0.00
```

```
07:00:00    0.08    0.00    0.00    0.78    2.02    0.00
08:00:00    0.09    0.00    0.00    0.78    2.02    0.00
08:20:00    0.11    0.00    0.00    0.87    2.24    0.00
08:40:01    0.13    0.00    0.00    0.90    2.29    0.00
09:00:00    0.11    0.00    0.00    0.88    2.24    0.00
09:20:00    0.10    0.00    0.00    0.88    2.24    0.00
09:40:00    2.91    1.80    2.38    4.61   17.62    0.00
10:00:00    2.74    2.03    3.08    8.17   21.76    0.00
10:20:00    0.16    0.04    0.04    1.92    2.96    0.00
10:40:00    2.10    2.50    3.42    6.62   16.51    0.00
11:00:00    3.36    0.87    1.35    3.92   15.12    0.00

Average     0.42    0.22    0.31    1.45    4.00    0.00
```

Checking Queue Activity

You can use the `sar -q` command to report the following information:

- The average queue length while the queue is occupied.
- The percentage of time that the queue is occupied.

```
$ sar -q
00:00:00 runq-sz %runocc swpq-sz %swpocc
```

The output from the `-q` option is as follows:

`runq-sz`	The number of kernel threads in memory that are waiting for a CPU to run. Typically, this value should be less than 2. Consistently higher values mean that the system might be CPU-bound.
`%runocc`	The percentage of time that the dispatch queues are occupied.
`swpq-sz`	The average number of swapped out processes.
`%swpocc`	The percentage of time in which the processes are swapped out.

EXAMPLE 27 Monitoring Queue Activity

The following example shows output from the `sar -q` command. If the `%runocc` value is high (greater than 90 percent) and the `runq-sz` value is greater than 2, the CPU is heavily loaded and response is degraded. In this case, additional CPU capacity might be required to obtain acceptable system response.

```
# sar -q
```

```
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:00 runq-sz %runocc swpq-sz %swpocc
01:00:00     1.0       7     0.0       0
02:00:00     1.0       7     0.0       0
03:00:00     1.0       7     0.0       0
04:00:00     1.0       7     0.0       0
05:00:00     1.0       6     0.0       0
06:00:00     1.0       7     0.0       0

Average      1.0       7     0.0       0
```

Checking Unused Memory

You can use the `sar -r` command to report the number of memory pages and swap-file disk blocks that are currently unused.

```
$ sar -r
00:00:00 freemem freeswap
01:00:00    2135   401922
```

The output from the `-r` option is as follows:

`freemem` The average number of memory pages that are available to user processes over the intervals sampled by the command. Page size is system-dependent.

`freeswap` The number of 512-byte disk blocks that are available for page swapping.

EXAMPLE 28 Monitoring Unused Memory

The following example shows output from the `sar -r` command.

```
$ sar -r
SunOS balmy 5.10 Generic_144500-10 sun4v    ...
00:00:04 freemem freeswap
01:00:00   44717  1715062
02:00:01   44733  1715496
03:00:00   44715  1714746
04:00:00   44751  1715403
05:00:00   44784  1714743
06:00:00   44794  1715186
07:00:00   44793  1715159
08:00:00   44786  1714914
08:20:00   44805  1715576
08:40:01   44797  1715347
```

```
09:00:00   44761  1713948
09:20:00   44802  1715478
09:40:00   41770  1682239
10:00:00   35401  1610833
10:20:00   34295  1599141
10:40:00   33943  1598425
11:00:00   30500  1561959

Average    43312  1699242
```

Checking CPU Utilization

You can use the `sar -u` command to display CPU utilization statistics.

```
$ sar -u
00:00:00    %usr    %sys    %wio   %idle
01:00:00       0       0       0     100
```

The `sar` command without any options is equivalent to the `sar -u` command. At any given moment, the processor is either busy or idle. When busy, the processor is in either user mode or system mode. When idle, the processor is either waiting for I/O completion or has no work to do.

The output from the `-u` option is as follows:

`%usr`	The percentage of time that the processor is in user mode
`%sys`	The percentage of time that the processor is in system mode
`%wio`	The percentage of time that the processor is idle and waiting for I/O completion
`%idle`	The percentage of time that the processor is idle and not waiting for I/O

A high `%wio` value generally means that a disk slowdown has occurred.

EXAMPLE 29 Monitoring CPU Utilization

The following example shows output from the `sar -u` command.

```
$ sar -u
00:00:04    %usr    %sys    %wio   %idle
01:00:00       0       0       0     100
02:00:01       0       0       0     100
```

```
03:00:00       0       0       0     100
04:00:00       0       0       0     100
05:00:00       0       0       0     100
06:00:00       0       0       0     100
07:00:00       0       0       0     100
08:00:00       0       0       0     100
08:20:00       0       0       0      99
08:40:01       0       0       0      99
09:00:00       0       0       0      99
09:20:00       0       0       0      99
09:40:00       4       1       0      95
10:00:00       4       2       0      94
10:20:00       1       1       0      98
10:40:00      18       3       0      79
11:00:00      25       3       0      72

Average        2       0       0      98
```

Checking System Table Status

You can use the `sar -v` command to report the status of the process table, inode table, file table, and shared memory record table.

```
$ sar -v
00:00:00  proc-sz    ov  inod-sz    ov  file-sz    ov   lock-sz
01:00:00   43/922     0 2984/4236    0  322/322     0    0/0
```

The output from the -v option is as follows:

`proc-sz` The number of process entries (`proc` structures) that are currently being used, or allocated, in the kernel.

`inod-sz` The total number of inodes in memory compared to the maximum number of inodes that are allocated in the kernel. This number is not a strict high watermark. The number can overflow.

`file-sz` The size of the open system file table. `sz` is given as `0`, because space is allocated dynamically for the file table.

`ov` The overflows that occur between sampling points for each table.

`lock-sz` The number of shared memory record table entries that are currently being used, or allocated, in the kernel. `sz` is given as `0` because space is allocated dynamically for the shared memory record table.

EXAMPLE 30 Monitoring System Table Status

The following abbreviated example shows output from the `sar -v` command. This example shows that all tables are large enough to have no overflows. These tables are all dynamically allocated based on the amount of physical memory.

```
$ sar -v
00:00:04  proc-sz    ov  inod-sz    ov  file-sz    ov   lock-sz
01:00:00   69/8010    0 3476/34703    0    0/0       0    0/0
02:00:01   69/8010    0 3476/34703    0    0/0       0    0/0
03:00:00   69/8010    0 3476/34703    0    0/0       0    0/0
04:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
05:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
06:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
07:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
08:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
08:20:00   69/8010    0 3494/34703    0    0/0       0    0/0
08:40:01   69/8010    0 3494/34703    0    0/0       0    0/0
09:00:00   69/8010    0 3494/34703    0    0/0       0    0/0
09:20:00   69/8010    0 3494/34703    0    0/0       0    0/0
09:40:00   74/8010    0 3494/34703    0    0/0       0    0/0
10:00:00   75/8010    0 4918/34703    0    0/0       0    0/0
10:20:00   72/8010    0 4918/34703    0    0/0       0    0/0
10:40:00   71/8010    0 5018/34703    0    0/0       0    0/0
11:00:00   77/8010    0 5018/34703    0    0/0       0    0/0
```

Checking Swapping Activity

You can use the `sar -w` command to report swapping and switching activity.

```
$ sar -w
00:00:00 swpin/s bswin/s swpot/s bswot/s pswch/s
01:00:00    0.00     0.0    0.00     0.0      22
```

The output from the `sar -w` command is as follows:

`swpin/s` The number of LWP transfers into memory per second.

`bswin/s` The number of blocks transferred for swap-ins per second. `/* (float) PGTOBLK(xx->cvmi.pgswapin) / sec_diff */`.

`swpot/s` The average number of processes that are swapped out of memory per second. If the number is greater than 1, you might need to increase memory.

`bswot/s` The number of blocks that are transferred for swap-outs per second.

`pswch/s` The number of kernel thread switches per second.

Note - All process swap-ins include process initialization.

EXAMPLE 31 Monitoring Swap Activity

The following example shows output from the `sar -w` command.

```
$ sar -w
00:00:04 swpin/s bswin/s swpot/s bswot/s pswch/s
01:00:00    0.00     0.0    0.00     0.0     132
02:00:01    0.00     0.0    0.00     0.0     133
03:00:00    0.00     0.0    0.00     0.0     133
04:00:00    0.00     0.0    0.00     0.0     134
05:00:00    0.00     0.0    0.00     0.0     133
06:00:00    0.00     0.0    0.00     0.0     133
07:00:00    0.00     0.0    0.00     0.0     132
08:00:00    0.00     0.0    0.00     0.0     131
08:20:00    0.00     0.0    0.00     0.0     133
08:40:01    0.00     0.0    0.00     0.0     132
09:00:00    0.00     0.0    0.00     0.0     132
09:20:00    0.00     0.0    0.00     0.0     132
09:40:00    0.00     0.0    0.00     0.0     335
10:00:00    0.00     0.0    0.00     0.0     601
10:20:00    0.00     0.0    0.00     0.0     353
10:40:00    0.00     0.0    0.00     0.0     747
11:00:00    0.00     0.0    0.00     0.0     804

Average     0.00     0.0    0.00     0.0     198
```

Checking Terminal Activity

You can use the `sar -y` command to monitor terminal device activities.

```
$ sar -y
00:00:00 rawch/s canch/s outch/s rcvin/s xmtin/s mdmin/s
01:00:00       0       0       0       0       0       0
```

If you have a lot of terminal I/O, you can use this report to determine whether any bad lines exist. The output from the `sar -y` command is as follows:

`rawch/s` Input characters (raw queue) per second

`canch/s` Input characters that are processed by canon (canonical queue) per second

`outch/s`	Output characters (output queue) per second
`rcvin/s`	Receiver hardware interrupts per second
`xmtin/s`	Transmitter hardware interrupts per second
`mdmin/s`	Modem interrupts per second

The number of modem interrupts per second (`mdmin/s`) should be close to zero. The receive and transmit interrupts per second (`xmtin/s` and `rcvin/s`) should be less than or equal to the number of incoming or outgoing characters, respectively. If not, check for bad lines.

EXAMPLE 32 Monitoring Terminal Activity

The following example shows output from the `sar -y` command.

```
$ sar -y
00:00:04 rawch/s canch/s outch/s rcvin/s xmtin/s mdmin/s
01:00:00       0       0       0       0       0       0
02:00:01       0       0       0       0       0       0
03:00:00       0       0       0       0       0       0
04:00:00       0       0       0       0       0       0
05:00:00       0       0       0       0       0       0
06:00:00       0       0       0       0       0       0
07:00:00       0       0       0       0       0       0
08:00:00       0       0       0       0       0       0
08:20:00       0       0       0       0       0       0
08:40:01       0       0       0       0       0       0
09:00:00       0       0       0       0       0       0
09:20:00       0       0       0       0       0       0
09:40:00       0       0       1       0       0       0
10:00:00       0       0      37       0       0       0
10:20:00       0       0       0       0       0       0
10:40:00       0       0       3       0       0       0
11:00:00       0       0       3       0       0       0

Average        0       0       1       0       0       0
```

Checking Overall System Performance

You can use the `sar -A` command to display statistics from all options to provide a view of overall system performance.

This command provides a more global perspective. If data from more than a single time segment is shown, the report includes averages.

Collecting System Activity Data Automatically

Three commands are involved in the automatic collection of system activity data: `sadc`, `sa1`, and `sa2`.

The `sadc` data collection utility periodically collects data on system activity and saves the data in a file in binary format, one file for each 24-hour period. You can set up the `sadc` command to run periodically (usually once each hour), and whenever the system boots to multi-user mode. The data files are placed in the `/var/adm/sa` directory. Each file is named `sa`*dd*, where *dd* is the current date. The format of the command is as follows:

`/usr/lib/sa/sadc [`*t n*`] [`*ofile*`]`

The command samples *n* times with an interval of *t* seconds, which should be greater than five seconds between samples. This command then writes to the binary *ofile* file, or to standard output.

Running the `sadc` Command When Booting

The `sadc` command should be run at system boot time to record the statistics from when the counters are reset to zero. To make sure that the `sadc` command is run at boot time, the `svcadm enable system/sar:default` command writes a record to the daily data file.

The command entry has the following syntax:

```
/usr/bin/su sys -c "/usr/lib/sa/sadc /var/adm/sa/sa`date +%d`"
```

Running the `sadc` Command Periodically With the `sa1` Script

To generate periodic records, you need to run the `sadc` command regularly. The simplest way to do so is to uncomment the following lines in the `/var/spool/cron/crontabs/sys` file.

```
# 0 * * * 0-6 /usr/lib/sa/sa1
# 20,40 8-17 * * 1-5 /usr/lib/sa/sa1
# 5 18 * * 1-5 /usr/lib/sa/sa2 -s 8:00 -e 18:01 -i 1200 -A
```

The default `sys crontab` entries perform the following functions:

- The first two `crontab` entries cause a record to be written to the `/var/adm/sa/sa`*dd* file every 20 minutes from 8 am to 5 pm, Monday through Friday, and every hour on the hour otherwise.

- The third entry writes a record to the `/var/adm/sa/sar`*dd* file hourly, Monday through Friday, and includes all `sar` options.

You can change these defaults to meet your needs.

Producing Reports With the `sa2` Shell Script

Another shell script, `sa2`, produces reports rather than binary data files. The `sa2` command invokes the `sar` command and writes the ASCII output to a report file.

Setting Up Automatic Data Collection

The `sar` command can be used either to gather system activity data itself or to report what has been collected in the daily activity files that are created by the `sadc` command.

The `sar` command has the following syntax:

```
sar [-aAbcdgkmpqruvwy] [-o file] t [n]

sar [-aAbcdgkmpqruvwy] [-s time] [-e time] [-i sec] [-f file]
```

The first format samples cumulative activity counters in the operating system every *t* seconds, *n* times. The *t* should be five seconds or greater. Otherwise, the command itself might affect the sample. You must specify a time interval in which to take the samples. Otherwise, the command operates according to the second format. The default value of *n* is 1.

The following example, using the second format, takes two samples separated by 10 seconds. If the `-o` option is specified, samples are saved in a binary format.

```
$ sar -u 10 2
```

The `sar` command with the second format, with no sampling interval or number of samples specified, extracts data from a previously recorded file. This file is either the file specified by the `-f` option or, by default, the standard daily activity file, `/var/adm/sa/sa`*dd*, for the most recent day.

The `-s` and `-e` options define the starting time and the ending time for the report. Starting and ending times are of the form *hh*[*:mm*[*:ss*]], where *hh*, *mm*, and *ss* represent hours, minutes, and seconds.

The `-i` option specifies, in seconds, the intervals between record selection. If the `-i` option is not included, all intervals that are found in the daily activity file are reported.

The `sar` options and their actions are as follows:

Note - Using no option is equivalent to calling the `sar` command with the `-u` option.

`-a`	Checks file access operations
`-b`	Checks buffer activity
`-c`	Checks system calls
`-d`	Checks activity for each block device
`-g`	Checks page-out and memory freeing
`-k`	Checks kernel memory allocation
`-m`	Checks interprocess communication
`-nv`	Checks system table status
`-p`	Checks swap and dispatch activity
`-q`	Checks queue activity
`-r`	Checks unused memory
`-u`	Checks CPU utilization
`-w`	Checks swapping and switching volume
`-y`	Checks terminal activity
`-A`	Reports overall system performance, which is the same as entering all options

▼ How to Set Up Automatic Data Collection

1. **Become an administrator.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Run the `svcadm enable system/sar:default` command.**

This version of the `sadc` command writes a special record that marks the time when the counters are reset to zero (boot time).

3. **Edit the `/var/spool/cron/crontabs/sys` `crontab` file.**

Note - Do not edit a `crontab` file directly. Instead, use the `crontab -e` command to make changes to an existing `crontab` file.

```
# crontab -e sys
```

4. **Uncomment the following lines:**

```
0 * * * 0-6 /usr/lib/sa/sa1
20,40 8-17 * * 1-5 /usr/lib/sa/sa1
5 18 * * 1-5 /usr/lib/sa/sa2 -s 8:00 -e 18:01 -i 1200 -A
```

For more information, see the `crontab(1)` man page.

♦ ♦ ♦ CHAPTER 4

Scheduling System Tasks

This chapter describes how to schedule routine system tasks or single (one-time) tasks using the Oracle Solaris Service Management Facility (SMF), the `crontab` command, and `at` command.

It covers the following topics:

Overview of Scheduled System Tasks

You can set up many system tasks to execute automatically. Some of these tasks should occur at regular intervals, while others for only a specific duration. Then, there are tasks that need to run only once, perhaps during off peak hours such as evenings and weekends.

This section contains overview information about scheduling system tasks using the Oracle Solaris Service Management Facility (SMF), or the `crontab` command or `at` command. Each has a primary function for which it should be used. In general, SMF provides a simpler scheduling mechanism for resource monitoring, though it does have `cron`-like scheduling capabilities. With SMF, you can set up both periodic services and scheduled services. A periodic service in SMF runs routine tasks within a designated time frame or "interval". An SMF scheduled service always runs according to an assigned start time. To execute repetitive or routine jobs (at a specific start time), use the `crontab` command. To schedule a single job or to execute a task once (at a specific time), use the `at` command.

The following table summarizes SMF, the `crontab` command, and the `at` command, as well as the files or properties for these functions.

TABLE 6 Tools for Automatically Executing Tasks

Tool	What It Schedules	Access Control Files or Properties

Periodic SMF service	Multiple system tasks at regular intervals (relative to the time of previous invocation)	`solaris.smf.modify`
		
		`solaris.smf.manage`

Scheduled SMF service	Multiple system tasks at a specific time	`scheduled/schedule` sets the frequency to run. Other `scheduled` properties specify the time to run.
`crontab` command	Multiple system tasks at regular intervals (but at specific times)	`/var/spool/cron/crontabs`
`at` command	A single system task at a specific time	`/var/spool/cron/atjobs`

Scheduling a Periodic or Scheduled Task With SMF

You can manage running applications or services with a Solaris service management facility known as SMF. Services are represented in the SMF framework by service objects, instance objects, and their configuration settings. The configuration of the local Oracle Solaris instance is called the `localhost scope`, and is the only supported scope as of now. For additional information, see the `smf(5)` man page.

SMF services that help systems run routine maintenance tasks at regular intervals are called *periodic* or *scheduled* services. A scheduled service is a type of periodic service that occurs at a specific time. Use a scheduled service for tasks that run occasionally or on a specific schedule (such as off-peak hours). For more information on scheduled services, see Chapter 4, “Creating a Service to Run on a Specific Schedule” in *Developing System Services in Oracle Solaris 11.3*.

A periodic service, on the other hand, begins the start method at a time relative to the last run. It is used for maintenance tasks that occur more frequently or regularly. In SMF, a periodic service is managed by the delegated restarter `svc:/system/svc/periodic-restarter`. This restarter runs the start method only for the instances that it manages. Thus, the scheduled task will begin only at specified intervals for the duration of time that such instances are online. For more information on periodic services, see Chapter 3, “Creating a Service to Run Periodically” in *Developing System Services in Oracle Solaris 11.3*.

The advantages of using SMF to schedule tasks are as follows:

- Automatically restarts any failed services in dependency order (whereas `cron` typically does not restart itself)
- Services are well integrated with the operating system and can easily be controlled with dependencies

- Debugs and reports on service problems, detailing why or how a scheduled service has failed
- Ensures that the task runs only when the (required) `IPS` package software is running
- Requires no additional steps for removing the scheduled task (uninstalls automatically with the `IPS` package)
- Delegates tasks to non-root users, with the ability to modify properties and manage services (which is not possible in `cron`)
- Manages multiple users in different time zones and settings

Note - Users without `root` access are unable to create their own scheduled services in SMF. Therefore, the `cron` or `at` commands are the only options for underprivileged users.

For step-by-step instructions on scheduling SMF tasks, see "Scheduling Repetitive System Tasks Using SMF" on page 93.

Scheduling a Routine System Task With `crontab` Command

`cron` runs a process that executes commands at specified dates and times. Unlike SMF, it only examines `crontab` or `at` command files during its own process initialization phase or when the two commands are run. It does not check for new or changed files at regularly scheduled intervals.

You can specify regularly scheduled commands to `cron` according to instructions found in the `crontab` files. Users can submit their own system tasks in `cron` using the `crontab` command; `root` access is not required as it is for SMF. The `crontab` command also allows you to schedule tasks that need to be executed more than once, whereas the `at` command only allows for a one-time run. Note that `cron` never exits, so it should be executed only once.

For step-by-step instructions on scheduling `crontab` jobs, see "How to Create or Edit a `crontab` File" on page 98.

Scheduling a Single System Task With `at` Command

The `at` command enables you to schedule a one-time task or an infrequent task for execution at a prescribed time. The job can consist of a single command or script.

Similar to `crontab`, the `at` command allows you to schedule the automatic execution of a system task. However, unlike `crontab` files, `at` files execute their tasks just once. They are then removed from their directory. Therefore, the `at` command is most useful for running simple commands or scripts that direct output into separate files for later examination.

Submitting an `at` job involves typing a command and following the `at` command syntax to specify options in order to schedule the time your job will be executed. For more information about submitting `at` jobs, see "Submitting an `at` Job File" on page 106.

The `at` command stores the command or script you ran, along with a copy of your current environment variable, in the `/var/spool/cron/atjobs` directory. The file name for an `at` job consists of a long number that specifies its location in the `at` queue followed by the `.a` extension, for example, `793962000.a`.

The `cron` daemon checks for `at` jobs at startup and listens for new jobs that are submitted. After the `cron` daemon executes an `at` job, the `at` job's file is removed from the `atjobs` directory. For more information, see the `at`(1) man page.

For step-by-step instructions on scheduling `at` jobs, see "How to Create an `at` Job" on page 107.

Examples of Repetitive System Tasks

You can schedule routine system administration tasks to execute daily, weekly, or monthly. Depending on the task requirements or assigned access control rights, you can use any one of the scheduling tools mentioned in "Overview of Scheduled System Tasks" on page 89.

Daily system administration tasks might include the following:

- Removing files more than a few days old from temporary directories
- Executing accounting summary commands
- Taking snapshots of the system by using the `df` and `ps` commands
- Performing daily security monitoring
- Running system backups

Weekly system administration tasks might include the following:

- Rebuilding the `catman` database for use by the `man -k` command
- Running the `fsck -n` command to list any disk problems

Monthly system administration tasks might include the following:

- Listing files not used during a specific month

- Producing monthly accounting reports

Additionally, you can schedule other routine system tasks, such as sending reminders and removing backup files.

Scheduling Repetitive System Tasks Using SMF

The following section includes information about how to create, modify, and display SMF service instances. It also covers information about SMF access controls:

- "How SMF Handles Scheduling" on page 93
- "Scheduling Method and Time Values for SMF" on page 93
- "How SMF Handles Scheduling" on page 93

How SMF Handles Scheduling

Each SMF scheduled service is managed by a restarter. The master restarter `svc.startd` manages states for the entire set of service instances and their dependencies. The master restarter acts on behalf of its services and on delegated restarters that can provide specific execution environments for certain application classes. For example, `inetd` is a delegated restarter that provides its service instances with an initial environment. Each service instance delegated to `inetd` is in the online state. While the daemon of a particular instance might not be running, the instance is available to run. As dependencies are satisfied when instances move to the online state, `svc.startd` invokes start methods of other instances which may overlap. See the `smf_restarter(5)` man page to view the configuration settings for all SMF restarters.

Each service or service instance must define a set of methods that start, stop, and, refresh the service. For a complete description of the method conventions for `svc.startd` and similar restarters, see the `smf_method(5)` man page. Administrative methods, such as for the capture of legacy configuration information into the repository, are discussed in the `svccfg(1M)` man page.

Scheduling Method and Time Values for SMF

A scheduled service instance in SMF requires a specific time which is delegated by the `scheduled_method` element. The `scheduled_method` element specifies both method and scheduling information for scheduled services.

TABLE 7 Acceptable Numerical Values for SMF Scheduling

Time Field	Numerical Values
Minute	0-59
Hour	0-23
Day of month	1-31
Month	1-12
Day of week	0-6 (0 = Sunday)

For more information on constraints and how to specify the `scheduled_method` element, see "Specifying the scheduled_method Element" in *Developing System Services in Oracle Solaris 11.3*.

Examples of SMF Manifests

EXAMPLE 33 Creating an SMF Scheduled Service

The following example shows how to create an SMF scheduled service instance to run automatically at 1:00 a.m. every Sunday morning.

```
<?xml version='1.0'?>
<!DOCTYPE service_bundle
  SYSTEM '/usr/share/lib/xml/dtd/service_bundle.dtd.1'>
<service_bundle type='manifest' name='site/sample-periodic-svc'>
    <service type='service' version='1' name='site/sample-periodic-svc'>

        <instance name='default' enabled='false'>

            <scheduled_method
                schedule='month'
                day='0'
                hour='1'
                minute='0'
                exec='/usr/bin/scheduled_service_method'
                timeout_seconds='0'>
                    <method_context>
                        <method_credential user='root' group='root' />
                    </method_context>
            </scheduled_method>

        </instance>
    </service>
```

```
</service_bundle>
```

For more step-by-step information on how to create a periodic service, see Chapter 3, "Creating a Service to Run Periodically" in *Developing System Services in Oracle Solaris 11.3*.

Scheduling a Repetitive System Task Using `crontab` Command

This section describes how to schedule routine system tasks by using the `crontab` command.

About the `crontab` File

The `cron` daemon schedules system tasks according to commands found within each `crontab` file. A `crontab` file consists of commands, one command per line, that will be executed at regular intervals. The beginning of each line contains date and time information that tells the `cron` daemon when to execute the command.

For example, a `crontab` file named `root` is supplied during the Oracle Solaris software installation. The file's contents include the following command lines:

```
10 3 * * * /usr/sbin/logadm      (1)
15 3 * * 0 /usr/lib/fs/nfs/nfsfind      (2)
1 2 * * * [ -x /usr/sbin/rtc ] && /usr/sbin/rtc -c > /dev/null 2>&1      (3)
30 3 * * * [ -x /usr/lib/gss/gsscred_clean ] && /usr/lib/gss/gsscred_clean      (4)
```

The output for each of these command lines is as follows:

- The first line runs the `logadm` command at 3:10 am every day.
- The second line executes the `nfsfind` script every Sunday at 3:15 am.

- The third line runs a script that checks for daylight savings time (and make corrections, if necessary) at 2:10 am daily.

  If there is no RTC time zone or /etc/rtc_config file, this entry does nothing.

  x86 only - The /usr/sbin/rtc script can be run only on an x86 based system.

- The fourth line checks for (and removes) duplicate entries in the Generic Security Service table, /etc/gss/gsscred_db, at 3:30 am daily.

For more information about the syntax of lines within a crontab file, see "Syntax of crontab File Entries" on page 97.

The crontab files are stored in the /var/spool/cron/crontabs directory. Several crontab files besides root are provided during Oracle Solaris software installation.

adm	Accounting
root	General system functions and file system cleanup
sys	Performance data collection
uucp	General uucp cleanup

Besides the default crontab files, you can create crontab files to schedule your own system tasks. Custom crontab files are named after the user accounts in which they are created, such as bob, mary, smith, or jones.

To access crontab files that belong to root or other users, superuser privileges are required.

How the cron Daemon Handles Scheduling

The cron daemon manages the automatic scheduling of crontab commands. The role of the cron daemon is to check the /var/spool/cron/crontab directory for the presence of crontab files.

The following tasks are performed by the cron daemon at startup.

- Checks for new crontab files
- Reads the execution times that are listed within the files

- Submits the commands for execution at the proper times
- Listens for notifications from the crontab commands regarding updated crontab files

In much the same way, the cron daemon controls the scheduling of at files. These files are stored in the /var/spool/cron/atjobs directory. The cron daemon also listens for notifications from the crontab commands regarding submitted at jobs.

Syntax of crontab File Entries

A crontab file consists of commands, one command per line, that execute automatically at the time specified by the first five fields of each command line, which are separated by spaces.

TABLE 8 Acceptable Values for crontab Time Fields

Time Field	Values
Minute	0-59
Hour	0-23
Day of month	1-31
Month	1-12
Day of week	0-6 (0 = Sunday)

The guidelines for using special characters in crontab time fields are as follows:

- Use a space to separate each field
- Use a comma to separate multiple values
- Use a hyphen to designate a range of values
- Use an asterisk as a wildcard to include all possible values
- Use a comment mark (#) at the beginning of a line to indicate a comment or a blank line

For example, the following crontab command entry displays a reminder in the user's console window at 4 pm on the first and fifteenth days of every month.

```
0 16 1,15 * * echo Timesheets Due > /dev/console
```

Each command within a crontab file must consist of one line, even if that line is very long. The crontab file does not recognize extra carriage returns. For more detailed information about crontab entries and command options, refer to the crontab(1) man page.

Creating and Editing crontab Files

The simplest way to create a crontab file is to use the crontab -e command. This command invokes the text editor that has been defined for your system environment in the EDITOR environment variable. If this variable has not been set, the crontab command uses the default editor, ed.

The following example shows how to determine whether an editor has been defined, and sets up vi as the default editor.

```
$ which $EDITOR
$
$ EDITOR=vi
$ export EDITOR
```

When you create a crontab file, it is automatically placed in the /var/spool/cron/crontabs directory and is given your user name. You can create or edit a crontab file for another user, or root if you have root privileges.

▼ How to Create or Edit a crontab File

Before You Begin If you are creating or editing a crontab file that belongs to another user, you must assume the root role. See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

You do not need to assume the root role to edit your own crontab file.

1. **Create a new crontab file, or edit an existing file.**

```
# crontab -e [username]
```

where *username* specifies the name of the user's account for which you want to create or edit a crontab file. You can create your own crontab file without superuser privileges, but you must have superuser privileges to creating or edit a crontab file for root or another user.

Caution - If you accidentally type the crontab command with no option, press the interrupt character for your editor. This enables you to quit without saving changes. If you instead save changes and exit the file, the existing crontab file will be overwritten with an empty file.

2. **Add command lines to the crontab file.**

Follow the syntax described in "Syntax of crontab File Entries" on page 97. The crontab file will be placed in the /var/spool/cron/crontabs directory.

3. **Verify your crontab file changes.**

```
# crontab -l [username]
```

Example 34 Creating a crontab File

The following example shows how to create a crontab file for another user.

```
# crontab -e mary
```

The following command entry added to a new crontab file automatically removes any log files from Mary's home directory at 1:00 am every Sunday morning. Because the command entry does not redirect output, redirect characters are added to the command line after *.log. Doing so ensures that the command executes properly.

```
# This command helps clean up user accounts.
1 0 * * 0 rm /home/mary/*.log > /dev/null 2>&1
```

Displaying and Verifying crontab Files

You can use the crontab -l command to display and verify contents of a crontab file.

Verifying That a crontab File Exists

To verify that a crontab file exists for a user, use the ls -l command in the /var/spool/cron/crontabs directory. The following sample output shows that crontab files exist for various users on the system.

```
$ ls -l /var/spool/cron/crontabs
drwxr-xr-x   2 root     sys           12 Nov 26 16:55 ./
drwxr-xr-x   4 root     sys            4 Apr 28  2012 ../
-rw-------   1 root     sys          190 Jun 28  2011 adm
-rw-------   1 root     staff          0 Nov 13  2012 mary
-rw-------   1 root     un           437 Oct  8  2012 johndoe
-r--------   1 root     root         453 Apr 28  2012 lp
-rw-------   1 root     sparccad      63 Jul 17 10:39 mary2
-rw-------   1 root     sparccad     387 Oct 14 15:15 johndoe2
```

```
-rw-------   1 root     other       2467 Nov 26 16:55 root
-rw-------   1 root     sys          308 Jun 28  2011 sys
-rw-------   1 root     siete        163 Nov 20 10:40 mary3
-r--------   1 root     sys          404 Jan 24  2013 uucp
```

Displaying a crontab File

The `crontab -l` command displays the contents of a `crontab` file the same way that the `cat` command displays the contents of other types of files. You do not have to change the directory to `/var/spool/cron/crontabs` (where `crontab` files are located) to use this command.

By default, the `crontab -l` command displays your own `crontab` file. To display `crontab` files that belong to other users, you must assume the root role.

The `crontab` command can be used as follows:

```
# crontab -l [username]
```

where *username* specifies the name of the user's account for which you want to display a `crontab` file. Displaying another user's `crontab` file requires `root` privileges.

Caution - If you accidentally type the `crontab` command with no option, press the interrupt character for your editor to quit without saving changes. If you instead save changes and exit the file, the existing `crontab` file will be overwritten with an empty file.

EXAMPLE 35 Displaying a `crontab` File

This example shows how to use the `crontab -l` command to display the contents of the default `crontab` file.

```
$ crontab -l
13 13 * * * chmod g+w /home1/documents/*.book > /dev/null 2>&1
```

EXAMPLE 36 Displaying the Default `root` `crontab` file.

This example shows how to display the default `root` `crontab` file.

```
$ su
Password:

# crontab -l
```

```
#ident  "@(#)root       1.19    98/07/06 SMI"   /* SVr4.0 1.1.3.1       */
#
# The root crontab should be used to perform accounting data collection.
#
#
10 3 * * * /usr/sbin/logadm
15 3 * * 0 /usr/lib/fs/nfs/nfsfind
30 3 * * * [ -x /usr/lib/gss/gsscred_clean ] && /usr/lib/gss/gsscred_clean
#10 3 * * * /usr/lib/krb5/kprop_script ___slave_kdcs___
```

EXAMPLE 37 Displaying the crontab File of Another User

This example shows how to display the crontab file that belongs to another user.

```
$ su
Password:
# crontab -l jones
13 13 * * * cp /home/jones/work_files /usr/backup/. > /dev/null 2>&1
```

Removing crontab Files

By default, crontab file protections are set up such that you cannot inadvertently delete a crontab file by using the rm command. Instead, use the crontab -r command to remove crontab files.

By default, the crontab -r command removes your own crontab file.

You do not have to change the directory to /var/spool/cron/crontabs (where crontab files are located) to use this command.

▼ How to Remove a crontab File

Before You Begin Become an administrator to remove a crontab file that belongs to root or another user. Roles contain authorizations and privileged commands. For more information, see "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

You do not need to assume the root role to remove your own crontab file.

1. **Remove the crontab file.**

```
# crontab -r [username]
```

where *username* specifies the name of the user's account for which you want to remove a crontab file. To remove crontab files for another user, assume the root role.

Caution - If you accidentally type the crontab command with no option, press the interrupt character for your editor to quit without saving changes. If you instead save changes and exit the file, the existing crontab file will be overwritten with an empty file.

2. **Verify that the crontab file has been removed.**

```
# ls /var/spool/cron/crontabs
```

Example 38 Removing a crontab File

The following example shows how user smith uses the crontab -r command to remove his own crontab file.

```
$ ls /var/spool/cron/crontabs
adm     jones     root    smith    sys     uucp
$ crontab -r
$ ls /var/spool/cron/crontabs
adm     jones root    sys    uucp
```

Controlling Access to the crontab Command

You can control access to the crontab command by using two files in the /etc/cron.d directory: cron.deny and cron.allow. These files permit only specified users to perform crontab command tasks such as creating, editing, displaying, or removing their own crontab files.

The cron.deny and cron.allow files consist of a list of user names, one user name per line.

These access control files work together as follows:

- If cron.allow exists, only the users who are listed in this file can create, edit, display, or remove crontab files.
- If cron.allow does not exist, all users can submit crontab files except for users who are listed in cron.deny.
- If neither cron.allow nor cron.deny exists, you must assume the root role to run the crontab command.
- In order to edit or create the cron.deny and cron.allow files, you must assume the root role.

The following user names are a part of the cron.deny file, which is created during the Oracle Solaris software installation.

```
$ cat /etc/cron.d/cron.deny
daemon
bin
smtp
nuucp
listen
nobody
noaccess
```

None of the user names in the default cron.deny file can access the crontab command. You can edit this file to add other users that will be denied access to the crontab command.

Because no default cron.allow file is supplied, all users except users who are listed in the default cron.deny file can access the crontab command. If you create a cron.allow file, only these users can access the crontab command.

▼ How to Deny crontab Command Access

1. **Assume the root role.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Edit the /etc/cron.d/cron.deny file and add user names, one user per line, who will be denied access to the crontab commands.**

   ```
   daemon
   bin
   smtp
   nuucp
   listen
   nobody
   noaccess
   username1
   username2
   username3
   .
   .
   .
   ```

3. **Verify that the /etc/cron.d/cron.deny file contains the new entries.**

   ```
   # cat /etc/cron.d/cron.deny
   ```

```
daemon
bin
nuucp
listen
nobody
noaccess
```

How to Limit `crontab` Command Access to Specified Users

1. **Assume the `root` role.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Create the `/etc/cron.d/cron.allow` file.**

3. **Add the `root` role to the `cron.allow` file.**

   If you do not add `root` to the file, root access to `crontab` commands will be denied.

4. **Add the user names, one user name per line, who will be allowed to use the `crontab` command.**

   ```
   root
   username1
   username2
   username3
   .
   .
   .
   ```

Example 39 Limiting `crontab` Command Access to Specified Users

The following example shows a `cron.deny` file that prevents user names `jones`, `temp`, and `visitor` from accessing the `crontab` command.

```
$ cat /etc/cron.d/cron.deny
daemon
bin
smtp
nuucp
listen
nobody
noaccess
jones
temp
```

```
visitor
```

The following example shows a `cron.allow` file. The users `root`, `jones`, and `smith` are the only users who can access the `crontab` command.

```
$ cat /etc/cron.d/cron.allow
root
jones
smith
```

Verifying Limited `crontab` Command Access

To verify whether a specific user can access the `crontab` command, use the `crontab -l` command while you are logged into the user account.

```
$ crontab -l
```

If the user can access the `crontab` command and already has created a `crontab` file, the file is displayed. The following message is displayed if the user can access the `crontab` command but no `crontab` file exists.

```
crontab: can't open your crontab file
```

Either this user is listed in the `cron.allow` file (if the file exists) or the user is not listed in the `cron.deny` file.

The following message is displayed if the user cannot access the `crontab` command, regardless of whether a previous `crontab` file exists.

```
crontab: you are not authorized to use cron. Sorry.
```

This message means that either the user is not listed in the `cron.allow` file (if the file exists) or the user is listed in the `cron.deny` file.

Scheduling A Single System Task by Using the `at` Command

This section describes how to schedule routine system tasks by using the `at` command. This section contains the following topics:

By default, users can create, display, and remove their own at job files. To access at files that belong to root or other users, you must assume the root role.

Submitting an at Job File

When you submit an at job, it is assigned a job identification number along with the .a extension. This designation becomes the job's file name as well as its queue number.

Submitting an at job file involves the following steps:

1. Invoking the at utility and specifying a command execution time.
2. Typing a command or script to execute later.

Note - If output from this command or script is important, be sure to direct the output to a file for later examination.

For example, the following at job removes core files from the user account smith near midnight on the last day of July.

```
$ at 11:45pm July 31
at> rm /home/smith/*core*
at> Press Control-d
commands will be executed using /bin/csh
job 933486300.a at Tue Jul 31 23:45:00 2004
```

Creating an at Job

The following task describes how to create and at job.

▼ How to Create an at Job

1. Start the at utility, specifying the time you want your job executed.

```
$ at [-m] time [date]
```

`-m`	Specifies to send you an email after the job is completed.
time	Specifies the hour that you want to schedule the job. Add `am` or `pm` if you do not specify the hours according to the 24-hour clock. Acceptable keywords are `midnight`, `noon`, and `now`. Minutes are optional.
date	Specifies the first three or more letters of a month, a day of the week, or the keywords `today` or `tomorrow`.

2. At the at prompt, type the commands or scripts that you want to execute, one per line.

You may type more than one command by pressing Return at the end of each line.

3. Press Control-D to exit the at utility and save the at job.

Your `at` job is assigned a queue number, which is also the job's file name. This number is displayed when you exit the `at` utility.

Example 40 Creating an `at` Job

The following example shows the `at` job that user `jones` created to remove her backup files at 7:30 p.m. She used the `-m` option so that she would receive an email message after her job completed.

```
$ at -m 1930
at> rm /home/jones/*.backup
at> Press Control-D
job 897355800.a at Thu Jul  12 19:30:00 2004
```

She received a email message which confirmed the execution of her `at` job.

```
Your “at” job “rm /home/jones/*.backup”
completed.
```

The following example shows how `jones` scheduled a large `at` job for 4:00 a.m. Saturday morning. The job output was directed to a file named `big.file`.

```
$ at 4 am Saturday
at> sort -r /usr/dict/words > /export/home/jones/big.file
```

Displaying the at Queue

To check your jobs that are waiting in the at queue, use the atq command.

```
$ atq
```

This command displays status information about the at jobs that you have created.

Verifying an at Job

To verify that you have created an at job, use the atq command. In the following example, the atq command confirms that the at jobs that belong to jones have been submitted to the queue.

```
$ atq
Rank   Execution Date     Owner     Job         Queue   Job Name
  1st   Jul 12, 2004 19:30   jones  897355800.a     a     stdin
  2nd   Jul 14, 2004 23:45   jones  897543900.a     a     stdin
  3rd   Jul 17, 2004 04:00   jones  897732000.a     a     stdin
```

Displaying at Jobs

To display information about the execution times of your at jobs, use the at -l command.

```
$ at -l [job-id]
```

where -l *job-id* is the optional identification number of a specific job whose status you want to display. Without an ID, the command displays the status of all jobs submitted by a user.

EXAMPLE 41 Displaying at Jobs

The following example shows sample output from the at -l command, which provides information about the status of all jobs submitted by a user.

```
$ at -l
897543900.a Sat Jul 14 23:45:00 2004
897355800.a Thu Jul 12 19:30:00 2004
897732000.a Tue Jul 17 04:00:00 2004
```

The following example shows sample output that is displayed when a single job is specified with the at -l command.

```
$ at -l 897732000.a
897732000.a  Tue Jul 17 04:00:00 2004
```

How to Remove at Jobs

Before You Begin Assume the root role to remove an at job that belongs to root or another user. See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

You do not need to assume the root role to remove your own at job.

1. **Remove the at job from the queue before the job is executed.**

   ```
   # at -r [job-id]
   ```

   where the -r *job-id* option specifies the identification number of the job you want to remove.

2. **Verify that the at job is removed by using the at -l (or the atq) command.**
   The at -l command displays the jobs remaining in the at queue. The job whose identification number you specified should not appear.

   ```
   $ at -l [job-id]
   ```

Example 42 Removing at Jobs

In the following example, a user wants to remove an at job that was scheduled to execute at 4 a.m. on July 17th. First, the user displays the at queue to locate the job identification number. Next, the user removes this job from the at queue. Finally, the user verifies that this job has been removed from the queue.

```
$ at -l
897543900.a Sat Jul 14 23:45:00 2003
897355800.a Thu Jul 12 19:30:00 2003
897732000.a Tue Jul 17 04:00:00 2003
$ at -r 897732000.a
$ at -l 897732000.a
at: 858142000.a: No such file or directory
```

Controlling Access to the at Command

You can set up a file to control access to the at command, permitting only specified users to create, remove, or display queue information about their at jobs. The file that controls access

to the at command, /etc/cron.d/at.deny, consists of a list of user names, one user name per line. The users who are listed in this file cannot access at commands.

The following user names are a part of the at.deny file, which is created during the Oracle Solaris software installation.

```
daemon
bin
smtp
nuucp
listen
nobody
noaccess
```

With superuser privileges, you can edit the at.deny file to add other user names whose at command access you want to restrict.

Denying Access to the at Command

As root, edit the /etc/cron.d/at.deny file to add the names of users that you want to prevent from using the at commands. Add only one user name per line.

```
daemon
bin
smtp
nuucp
listen
nobody
noaccess
username1
username2
username3
.
.
.
```

EXAMPLE 43 Denying at Access

The following example shows an at.deny file that has been edited so that the users smith and jones cannot access the at command.

```
$ cat at.deny
daemon
bin
```

```
smtp
nuucp
listen
nobody
noaccess
jones
smith
```

Verifying That the at Command Access is Denied

To verify that a username was added correctly to the /etc/cron.d/at.deny file, use the at -l command while logged in as the user. For example, if the logged-in user smith cannot access the at command, the following message is displayed:

```
# su smith
Password:
# at -l
at: you are not authorized to use at.  Sorry.
```

Likewise, if the user tries to submit an at job, the following message is displayed:

```
# at 2:30pm
at: you are not authorized to use at.  Sorry.
```

This message confirms that the user is listed in the at.deny file.

If at command access is allowed, then the at -l command returns nothing.

♦ ♦ ♦ CHAPTER 5

Managing the System Console, Terminal Devices, and Power Services

This chapter describes how to manage the system console and locally connected terminal devices through the `ttymon` program and system power services.

This chapter covers the following topics:

SMF Services That Manage the System Console and Locally Connected Terminal Devices

The system console and locally connected terminal devices are represented as instances of the SMF service, `svc:/system/console`. This service defines most of the behavior, with each instance having specific overrides to the settings that are inherited from the service. The `ttymon` program is used to offer login services for these terminals. Each terminal uses a separate instance of the `ttymon` program. Command-line arguments that are passed by the service to the `ttymon` program govern its behavior.

The service instances that are supplied with the system are as follows:

- `svc:/system/console-login:default`

  The default instance always represents that the `ttymon` program offer a login to the system hardware console.
- `svc:/system/console-login:{vt2, vt3, vt4, vt5, vt6}`

  Additional service instances are provided for the system's virtual consoles. If virtual consoles are not available, these services are automatically disabled. For more information, see the `vtdaemon(1M)` man page.
- `svc:/system/console-login:{terma, termb}`

The `svc:/system/console-login:terma` and `svc:/system/console-login:termb` services are provided as a convenience. These services can assist you in setting up login services for additional `/dev/term/a` and `/dev/term/b` ports. These services are disabled by default.

You can define additional service instances as part of the `svc:system/console-login` service. For example, if you have a `/dev/term/f` port that you need to support, you could initiate `svc:/system/console-login:termf` and configure it appropriately.

How to Set Up Login Services on Auxiliary Terminals

For terminals that are connected to `/dev/term/a` or `/dev/term/b` serial ports on a system, predefined services are provided.

1. **Become an administrator.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Enable the service instance.**

   For example, to enable login services for `/dev/term/a`:

   ```
   # svcadm enable svc:/system/console-login:terma
   ```

3. **Check that the service is online.**

   ```
   # svcs svc:/system/console-login:terma
   ```

   The output should show that the service is online. If the service is in maintenance mode, consult the service's log file for further details.

How to Set the Baud Rate Speed on the Console

Support for console speeds on x86 based systems are dependent on the specific platform.

The following console speeds are supported on a SPARC based system:

- `9600 bps`

- 19200 bps
- 38400 bps

1. **Become an administrator.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Use the `eeprom` command to set a baud rate speed that is appropriate for your system type.**

   ```
   # eeprom ttya-mode=baud-rate,8,n,1,-
   ```

   For example, to change the baud rate on an x86 based system's console to `38400`, type:

   ```
   # eeprom ttya-mode=38400,8,n,1,-
   ```

3. **Change the console line in the `/etc/ttydefs` file as follows:**

   ```
   console baud-rate hupcl opost onlcr:baud-rate::console
   ```

4. **Make the following additional changes for your system type.**

   Note that these changes are platform-dependent.

   - **On SPARC based systems:** Change the baud rate speed in the version of the `options.conf` file that is in the `/etc/driver/drv` directory.

     For example, to change the baud rate to `9600`:

     ```
     # 9600              :bd:
     ttymodes="2502:1805:bd:8a3b:3:1c:7f:15:4:0:0:0:11:13:1a:19:12:f:17:16";
     ```

     To change the baud rate speed to `19200`:

     ```
     # 19200             :be:
     ttymodes="2502:1805:be:8a3b:3:1c:7f:15:4:0:0:0:11:13:1a:19:12:f:17:16";
     ```

     To change the baud rate speed to `38400`:

     ```
     # 38400             :bf:
     ttymodes="2502:1805:bf:8a3b:3:1c:7f:15:4:0:0:0:11:13:1a:19:12:f:17:16";
     ```

   - **On x86 based systems:** Change the console speed if the BIOS serial redirection is enabled.

Managing System Power Services

In the Oracle Solaris 11 operating system, power management configuration has moved into an SMF configuration repository. The new `poweradm` command is used to manage system power management properties directly rather than using a combination of power-related command, daemon, and configuration file. These changes are part of a wider set of changes to modernize the power management framework in the Oracle Solaris operating system.

The following power management features are no longer available:

- `/etc/power.conf`
- `pmconfig` and `powerd`
- Device power management

The following properties describe power management components:

- `administrative-authority` – Defines the source of administrative control for Oracle Solaris power management. This property can be set to `none`, `platform` (default value), or `smf`.

  When set to `platform`, the values of `time-to-full-capacity` and `time-to-minimum-responsiveness` are taken from the platform's power management commands.

  When set to `smf`, the values of `time-to-full-capacity` and `time-to-minimum-responsiveness` are taken from SMF.

  If you attempt to set `time-to-full-capacity` or `time-to-minimum-responsiveness` from either a platform command or an SMF service property when in the opposite venue, the value is ignored.

  When `administrative-authority` is set to `none`, power management within the Oracle Solaris instance is turned off.
- `time-to-full-capacity` – Defines the maximum time (in microseconds) the system is allowed to reach its full capacity, from any lower-capacity or less-responsive state, while the system is in active state. The maximum time includes the time while it has been using any or all of the PM features falling within this boundary.

  By default, this value is taken from the platform, `i86pc` for example, because the default setting for `administrative-authority` is set to platform.

  Alternatively, if `administrative-authority` is set to `smf`, this value is taken from the definition provided by the SMF power service. At the time of installation, this value is undefined. If you choose to modify this property, a value appropriate to the needs of the system's workload or applications should be considered.
- `time-to-minimum-responsiveness` – Defines how long the system is allowed to return to its active state in milliseconds. This parameter provides the minimum capacity

required to meet the `time-to-full-capacity` constraint. Because the default setting for `administrative-authority` is set to platform by default, this parameter value is taken from the platform, `i86pc` for example..

Alternatively, if `administrative-authority` is set to `smf`, this value is taken from the definition provided by the SMF power service . At installation time, this value is undefined. If you choose to modify this property, use a value appropriate to the needs of the system's workload or applications.

Moderate values, seconds for example, allow hardware components or subsystems on the platform to be placed in slower-response inactive states. Larger values, 30 seconds to minutes, for example, allow for whole system suspension, using techniques such as suspend-to-RAM.

- `suspend-enable` – By default, no system running Oracle Solaris is permitted to attempt a suspend operation. Setting this property to true permits a suspend operation to be attempted. The value of the `administrative-authority` has no effect upon this property.
- `platform-disabled` – When `platform-disabled` is set to `true`, the platform has disabled power management. When set to `false`, the default value, power management is controlled by the value of the above properties.

To display a brief summary of power management status, use the following command:

```
$ /usr/sbin/poweradm show
Power management is enabled with the hardware platform as the authority:
time-to-full-capacity set to 250 microseconds
time-to-minimum-responsiveness set to 0 milliseconds
```

To display power management properties, issue the following command:

```
$ /usr/sbin/poweradm list
active_config/time-to-full-capacity          current=250, platform=250
active_config/time-to-minimum-responsiveness current=0, platform=0
active_control/administrative-authority      current=platform, smf=platform
suspend/suspend-enable                       current=false
platform-disabled                            current=false
```

In this output, the `active_control/administrative-authority` indicates the source of the configuration with two settings.

- `platform` – Configuration for power management comes from the platform. This is the default value.
- `smf` – Allows the other power management properties to be set using the `poweradm` command.

The `platform-disabled` property in the output indicates that the platform power management is enabled.

```
platform-disabled                           current=false
```

For more information, see the poweradm(1M) man page.

EXAMPLE 44 Enabling and Disabling Power Management

If you previously enabled S3-support in the /etc/power.conf file to suspend and resume your system, a similar poweradm syntax is as follows:

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

The suspend-enable property is set to false by default.

Use the following syntax to disable power management:

```
# poweradm set administrative-authority=none
```

Disabling the following SMF power management service does not disable power management:

```
online         Sep_02   svc:/system/power:default
```

Use the following syntax to disable suspend and resume:

```
# poweradm set suspend-enable=false
```

EXAMPLE 45 Setting and Displaying Power Management Parameters

The following example shows how to set time-to-full-capacity to 300 microseconds, set time-to-minimum-responsiveness to 500 milliseconds, and inform the Oracle Solaris instance of the new values.

```
# poweradm set time-to-full-capacity=300
# poweradm set time-to-minimum-responsiveness=500
# poweradm set administrative-authority=smf
```

The following command shows the current time-to-full-capacity value:

```
# poweradm get time-to-full-capacity
300
```

The following command retrieves the time-to-full-capacity value set by the platform:

```
# poweradm get -a platform time-to-full-capacity
```

Note that this value will be the same as the current value only if administrative-authority is set to platform. For more information, see the description of the administrative-authority property at the beginning of this section. See also the poweradm(1M) man page.

How to Recover from Power Service in Maintenance Mode

If `administrative-authority` is set to `smf` before `time-to-full-capacity` and `time-to-minimum-responsiveness` have been set, the service will go into maintenance mode. See the task below to recover from this scenario.

1. **Become an administrator.**

   See "Using Your Assigned Administrative Rights" in *Securing Users and Processes in Oracle Solaris 11.3*.

2. **Set `administrative-authority` to `none`.**

   ```
   # poweradm set administrative-authority=none
   ```

3. **Set both `time-to-full-capacity` and `time-to-minimum-responsiveness` to their desired values.**

   ```
   # poweradm set time-to-full-capacity=value
   # poweradm set time-to-minimum-responsiveness=value
   ```

4. **Clear the service.**

   ```
   # svcadm clear power
   ```

5. **Set `administrative-authority` to `smf`.**

   ```
   # poweradm set administrative-authority=smf
   ```

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