HP Process Resource Manager User's Guide

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Legal Notice

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Preface

This document describes Release C.03.04 of HP Process Resource Manager (PRM).

The intended audience for this document is system administrators.

New in this edition

This edition includes information on the following changes and additions:

- `prmconfig` now has a `-c` option

  The `prmconfig -c` option performs a subset of the `prmconfig -s` checks. The only difference in the two options is in checking the password file. The `-s` check verifies every user name in the PRM configuration is in the password file and that every user name in the password file is in the PRM configuration. The `-c` check only verifies that user names in the PRM configuration are in the password file.

- New minimum for shared memory records

  Previously, you had to specify a minimum of 1 megabyte in shared memory records. The minimum now corresponds to the page size. Page sizes can be 4KB, 8KB, 16KB, or 64KB. You must have at least 256 pages, so the minimum values are now 1, 2, 4, or 16 depending on the system's page size.

Supported platforms

HP Process Resource Manager (PRM) Version C.03.04 supports the:

- HP-UX 11i v1 (B.11.11) operating system on HP 9000 servers
- HP-UX 11i v2 (B.11.23) and HP-UX 11i v3 (B.11.31) operating systems running on either HP 9000 servers or HP Integrity servers

Notational conventions

This section describes notational conventions used in this document.

`bold monospace`	In command examples, **`bold monospace`** identifies input that must be typed exactly as shown.

`monospace`	In paragraph text, `monospace` identifies command names, system calls, and data structures and types. It also identifies PRM group names. In command examples, `monospace` identifies command output, including error messages.
italic	In paragraph text, *italic* identifies titles of documents.
`italic`	In command syntax diagrams, *`italic`* identifies variables that you must provide.
Brackets ([ ])	In command examples, square brackets designate optional entries. The following command example uses brackets to indicate that the variable *`output_file`* is optional: `command` *`input_file`* [*`output_file`*]
Curly brackets ({}), Pipe (|)	In command syntax diagrams, text surrounded by curly brackets indicates a choice. The choices available are shown inside the curly brackets, separated by the pipe sign (|). The following command example indicates that you can enter either `a` or `b`: `command {a | b}`
Horizontal ellipses (...)	In command examples, horizontal ellipses show repetition of the preceding items.
Keycap	**Keycap** indicates the keyboard keys you must press to execute the command example.
File->New	Menu and menu items separated by an arrow (**->**) indicate a selection of menu items starting from the menu bar.

NOTE A note highlights important supplemental information.

Associated documents

Associated documents include:

- *HP PRM Version C.03.04 Release Notes*
- prm(1) manpage
- prm1d(1) manpage
- prm2d(1) manpage
- prmagt(1) manpage
- prmanalyze(1) manpage
- prmavail(1) manpage
- prmconfig(1) manpage
- prminitconfig(1) manpage
- prmlist(1) manpage
- prmloadconf(1) manpage
- prmmonitor(1) manpage
- prmmove(1) manpage
- prmrecover(1) manpage
- prmrun(1) manpage
- prmconf(4) manpage
- prmsmhconfig(1) manpage
- prm2scomp(1) manpage
- scomp2prm(1) manpage
- srpgen(1) manpage
- *HP-UX System Administrator's Guide* (HP-UX 11i v3)
- *Managing Systems and Workgroups* (HP-UX 11i v1 and HP-UX 11i v2)
- *Managing ServiceGuard*

The *HP-UX System Administrator's Guide*, *Managing Systems and Workgroups*, and the *Managing ServiceGuard* documents, along with many other Hewlett-Packard documents, are available on the web at http://docs.hp.com.

Providing feedback

- Email your feedback to the PRM development team at the following address:

  prmfeedback@rsn.hp.com

- For a forum with other PRM users, visit the IT Resource Center's forum for HP-UX Workload/Resource Management:

  http://forums.itrc.hp.com/cm/

- For the latest patch information, white papers, and documentation, visit the Process Resource Manager web page:

  http://www.hp.com/go/prm/

Support and patch policies

The http://www.hp.com/go/prm site provides information on PRM's support policy and patch policy. These policies indicate the time periods for which this version of PRM is supported and patched.

Training

HP offers a course in HP-UX resource management using PRM. For information, including a course outline, visit:

http://www.hp.com/education/courses/u5447s.html

1 Overview

This chapter introduces the basic concepts and functions of HP Process Resource Manager. It covers:

- What is HP Process Resource Manager?
- Why use HP Process Resource Manager?

What is HP Process Resource Manager?

Process Resource Manager (PRM) is a resource management tool used to control the amount of resources that processes use during peak system load (at 100% CPU resource, 100% memory resource, or 100% disk bandwidth utilization). PRM can guarantee a minimum allocation of system resources available to a group of processes through the use of PRM groups.

A PRM group is a collection of users and applications that are joined together and assigned certain amounts of CPU resource, memory resource, and disk bandwidth. The two types of PRM groups are FSS PRM groups and PSET PRM groups. An FSS PRM group is the traditional PRM group, whose CPU entitlement is specified in shares. This group uses the Fair Share Scheduler (FSS) in the HP-UX kernel within the system's default processor set (PSET). A PSET PRM group is a PRM group whose CPU entitlement is specified by assigning it a subset of the system's cores (PSET). (A core is the actual data-processing engine within a processor. A single processor might have multiple cores. A core might support multiple execution threads, as explained in the section "Hyper-Threading" on page 49.) Processes in a PSET have equal access to CPU cycles on their assigned cores through the HP-UX standard scheduler.

PRM has four managers:

CPU (processor time)

Ensures that each PRM group is granted at least its allocation of CPU resources. Optionally for FSS PRM groups, this resource manager ensures no more than its capped amount of CPU resources. For PSET PRM groups, processes are capped on CPU resource usage by the number of cores assigned to the group.

MEM (memory)

Can manage both private memory and shared memory.

- For private memory:

  Ensures that each PRM group is granted at least its share, but (optionally) no more than its capped amount of memory. You can also specify memory shares be isolated so that a group's assigned memory shares cannot be loaned out to, or borrowed from, other groups.

- For shared memory:

  Ensures a PRM group is allocated a minimum number of megabytes for use as shared memory.

DISK (disk bandwidth)

Ensures that each FSS PRM group is granted at least its share of disk bandwidth. PRM disk bandwidth management can only control disks that are managed by HP's Logical Volume Manager (LVM) or by VERITAS Volume Manager™ (VxVM®). PSET PRM groups are treated as part of PRM_SYS (`PRMID 0`) for disk bandwidth purposes.

APPL (application)

Ensures that specified applications and their child processes run in the appropriate PRM groups.

The managers control resources, user processes, compartment processes, and applications based on records in the configuration. Each manager has its own record type. The most important records are PRM group/CPU records, because all other records must reference these defined PRM groups. The various records are described below.

Group/CPU — Specifies a PRM group's name and its CPU allocation. The two types of PRM group records are FSS PRM group records and PSET PRM group records. An FSS PRM group is the traditional PRM group, whose CPU entitlement is specified in shares. This group uses the Fair Share Scheduler (FSS) in the HP-UX kernel within the system's default processor set (PSET). A PSET PRM group is a PRM group whose CPU entitlement is specified by assigning it a subset of the system's cores (PSET). Processes in a PSET have equal access to CPU cycles on their assigned cores through the HP-UX standard scheduler.

Memory — Specifies a PRM group's memory allocation, either of private memory or shared memory. There are two types of memory records:

- Private

  Specifies a minimum amount of private memory. Optionally specifies a cap on memory use as well as memory isolation (so that memory cannot be loaned out or borrowed from other groups).

- Shared

  Specifies a minimum amount of memory in megabytes for use as shared memory for the processes in that PRM group.

  PRM groups without a shared memory record default to `PRM_SYS` for shared memory allocation.

Disk bandwidth — Specifies an FSS PRM group's disk bandwidth shares for a given logical volume group (LVM) or disk group (VxVM). You cannot specify disk bandwidth records for PSET PRM groups. PSET PRM groups are treated as part of PRM_SYS (PRMID 0) for disk bandwidth purposes.

Application	Specifies an application (either explicitly or by regular expression) and the PRM group in which the application should run. Optionally, it specifies alternate names the application can take at execution. (Alternate names are most common for complex programs such as database programs that launch many processes and rename them.)
User	Specifies a user or a collection of users (through a netgroup) and assigns the user or netgroup to an initial PRM group. Optionally, it specifies alternate PRM groups. A user or netgroup member then has permissions to use these PRM groups with the `prmmove` and `prmrun` commands.
Unix group	Maps existing Unix groups to PRM groups.
Compartment	Maps existing secure compartments to PRM groups. (Use the optional HP-UX feature Security Containment to create the secure compartment configurations. You can also create compartment configurations using a PRM utility such as `srpgen` or `prm2scomp`.)

For more detailed information on records, see the prmconf(4) manpage.

Introduction to PRM commands

PRM supports the commands below. For more information about a command, see its manpage or the “Command reference” on page 201.

`prmagt`

PRM’s read-only SNMP agent.

`prmanalyze`

Allows you to analyze resource usage and contention to help plan PRM configurations.

`prmavail`

Displays estimated resource availability to help plan PRM configurations.

`prmconfig`

Configures, enables, disables, and resets PRM. Also, validates PRM configuration files and controls PRM's message logging. You can also perform these tasks using the PRM graphical interface in HP System Management Homepage (SMH) or HP Systems Insight Manager (SIM).

`prminitconfig`

Configure or unconfigure the PRM GUI to be available in HP Systems Insight Manager (SIM).

`prmlist`

Displays the current PRM group, memory, user, application, and disk configuration information.

`prmloadconf`

Creates a PRM configuration file or updates an existing configuration file.

`prmmonitor`

Monitors current PRM configuration and resource usage by PRM group.

`prmmove`

Moves processes or groups of processes to another PRM group.

`prmrecover`

Cleans up processes after abnormal memory manager termination.

`prmrun`

Runs an application in its assigned group or in a specified group.

`prmsmhconfig`

Configure or unconfigure the PRM GUI to be available in HP System Management Homepage (SMH).

`prm2scomp`

Generates a minimal Security Containment configuration based on a PRM configuration. (The Security Containment configuration defines secure compartments. You can also create compartment configurations using the PRM utility `srpgen`.)

Available starting with HP-UX 11i v2 (B.11.23).

`scomp2prm`

Generates a minimal PRM configuration based on a Security Containment configuration. (The Security Containment configuration defines secure compartments.You can also create compartment configurations using a PRM utility such as `srpgen` or `prm2scomp`.)

Available starting with HP-UX 11i v2 (B.11.23).

`srpgen`

Generates Secure Resource Partitions by creating both a minimal Security Containment configuration and a minimal PRM configuration based on your input.

Available starting with HP-UX 11i v2 (B.11.23).

Why use HP Process Resource Manager?

The standard HP-UX CPU scheduler and memory manager allocate resources to processes based on the assumption that all processes are of equal importance. PRM, however, allows the system administrator to group processes and specify the level of importance for that group. PRM allocates CPU resources, real memory resources (private and shared), and disk bandwidth resources to the group based on its assigned importance.

Reasons to use PRM:

- Improve the response time for critical users and applications.
- Set and manage user expectations for performance.
- Allocate shared servers based on budgeting.
- Ensure that an application package in a Serviceguard cluster has sufficient resources on an active standby system in the event of a failover.
- Ensure that critical users or applications have sufficient CPU, memory, and disk bandwidth resources.

  Users who at times run critical applications, may at other times engage in relatively trivial tasks. These trivial tasks may be competing in the users' PRM group with critical applications for available CPU and real memory resources. For this reason, it is often useful to separate applications into different PRM groups or create alternate groups for a user. You can assign a critical application its own PRM group to ensure that the application gets the needed share of resources.

- Restrict the CPU, real memory, and disk bandwidth resources available to relatively low-priority users and applications during times of heavy demand.

  For example, mail readers can consume significant disk bandwidth when users first come into work or return from lunch. Therefore, you may want to assign an application like `mail` to a PRM group with small resource allocations and restrict the amount of resources `mail` can use during such times of heavy demand on the system.

- Monitor resource consumption by users or applications.

  Assigning a group of users or applications to separate PRM groups can be a good way to keep track of the resources they are using. For information on various PRM reports, see "Monitoring PRM groups" on page 184.

Table 1-1 lists the resources that PRM can manage. For more information about how a resource is managed, see "Understanding how PRM manages resources" on page 33.

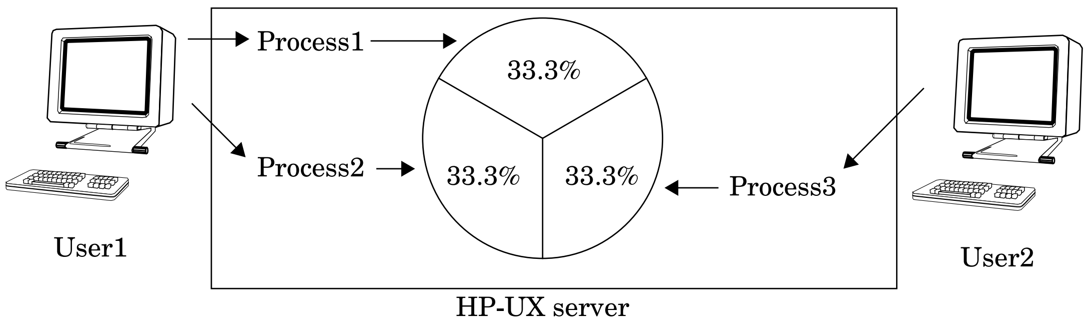
Table 1-1 Resources managed by PRM

Resource managed	Shares	Cap	Management algorithm
CPU	Yes (for FSS PRM groups)	Yes (on all groups in CPUCAPON mode; on a per-group basis is also available for HP-UX 11i v3 and later)	PRM allocates time slices to FSS PRM groups proportional to their shares. When CPUCAPON mode is enabled, the FSS PRM group is given CPU time regardless of whether the time is needed. With per-group capping, the CPU time remains available to other PRM groups. For PSET PRM groups, PRM allocates entire cores to the group according to the current configuration. CPU capping for PSET PRM groups is a result of the number of cores assigned to the group.
Disk bandwidth	Yes	No	PRM re-orders the volume group’s (or disk group’s) I/O requests in the kernel based on the PRM group shares.
Real memory (private)	Yes	Yes (on a per-group basis)	When the system is paging (real memory is exhausted), if a PRM group is exceeding its shares, the Memory Resource Groups (MRG) kernel causes the process to page.
Real memory (shared)	N/A	N/A	The amount of memory requested is set aside for use as shared memory.

Standard HP-UX resource allocation

Under standard HP-UX resource allocation, all processes are treated equally. Figure 1-1 illustrates how a user, by starting multiple processes, can consume a majority of an available resource because the processes each get equal amounts. As illustrated, User1 starts two processes and User2 starts one process. Using HP-UX standard resource allocation, User1 could control two-thirds of the available resource while User2 gets one-third, regardless of the importance of each process.

Figure 1-1 HP-UX standard resource allocation



How PRM can improve on standard allocation

Unlike the standard scheduler, PRM allows you to set priorities on your processes. The following sections illustrate various ways you can use PRM to improve scheduling.

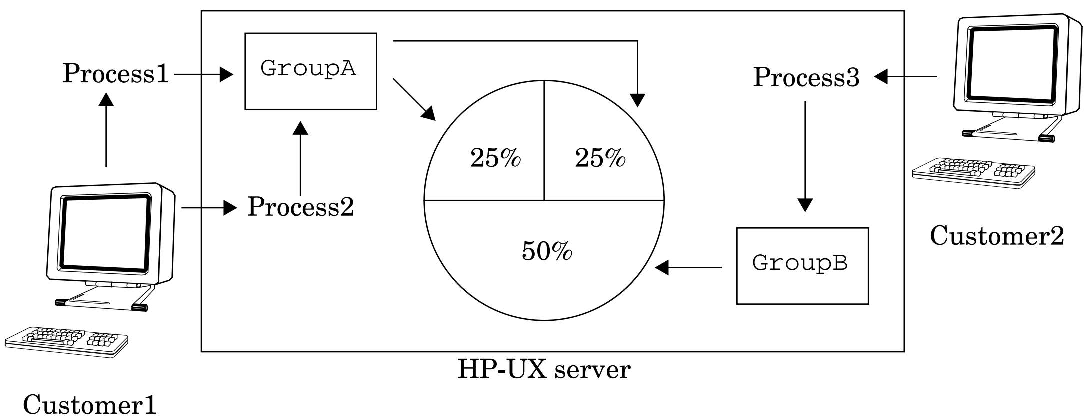
If multiple users or applications within a PRM group are competing for resources, standard HP-UX resource management practices determine resource allocation.

Balancing resource use between users

Figure 1-2 shows how PRM can alter standard resource allocation and balance system resource use.

In the following scenario, a service provider wants each customer to have an equal share of the machine. Each customer is assigned to a separate PRM group, which is given resource shares equivalent to 50%. The resource being allocated could be either CPU, disk bandwidth, or memory. This configuration guarantees each PRM group 50% of the resource for any given interval. Thus, Customer2's process receives 50% of the resource; however, because Customer1's group contains two processes, each of Customer1's processes receive 25% of the resource. This scenario assumes that the three processes fully consume the resource allocated to their groups.

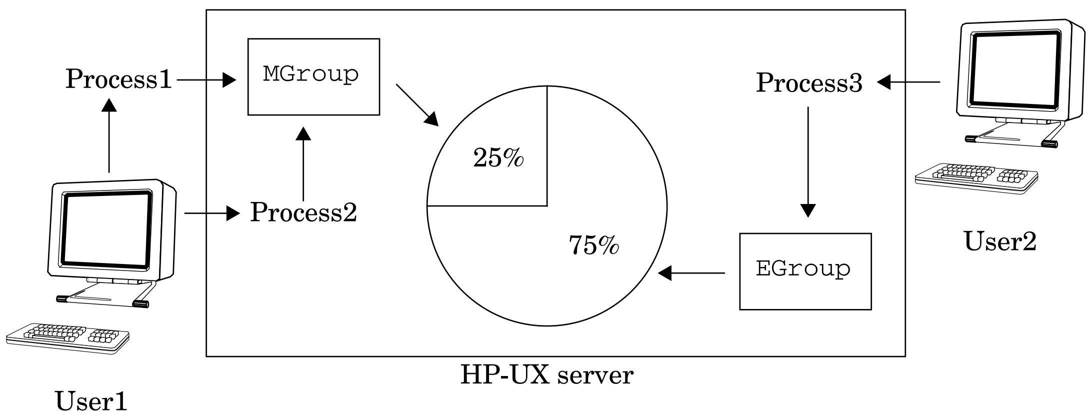
Figure 1-2 Balancing resource use between users



Prioritizing resource use between users

Figure 1-3 illustrates how users' access to resources can be prioritized using PRM. In this example, two university departments both contributed to the purchase of a new computer. The math department paid 25% of the cost, and the engineering department paid 75%. PRM groups are assigned accordingly: 25% for the math PRM group `MGroup` and 75% for the engineering PRM group `EGroup`. This implies that `EGroup` processes have priority over `MGroup` processes. Each group has only one user: User1 is in `MGroup`; User2 is in `EGroup`. User1 is entitled to 25% of the available resource, and User2 is entitled to 75%. This scenario assumes that the three processes fully consume the resource allocated to their groups.

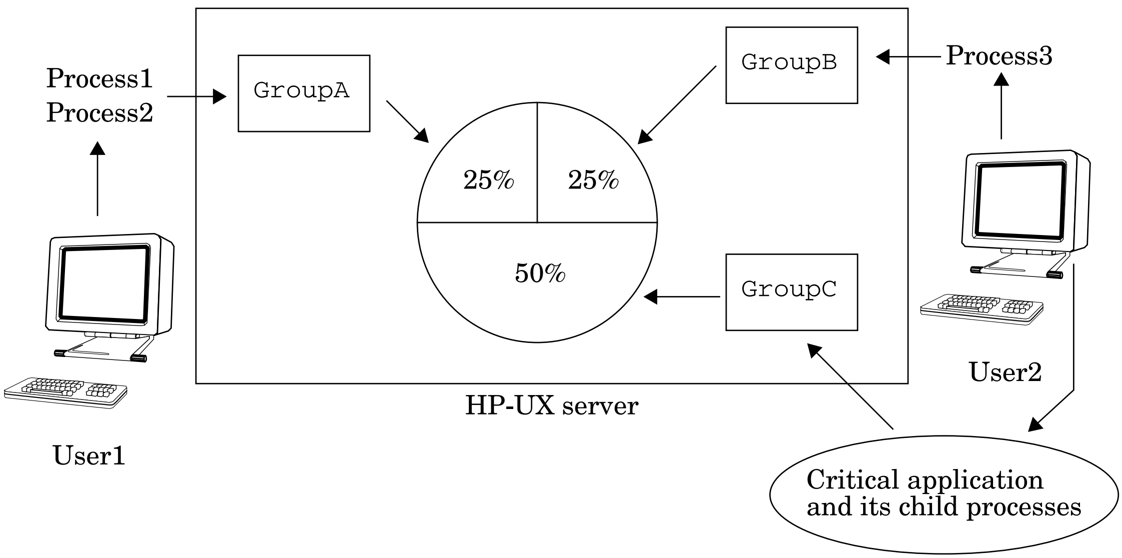
Figure 1-3 Prioritizing resource use between users



Prioritizing resource use for applications

Figure 1-4 illustrates a situation where two users and an application are assigned to separate PRM groups. User1 and User2 are respectively assigned to `GroupA` and `GroupB`. Both groups are given 25%. The critical application is assigned to `GroupC`, which is given 50%. Because of its greater resource allocation, `GroupC` takes priority over `GroupA` and `GroupB`. This scenario assumes that the processes fully consume the resource allocated to their groups.

Figure 1-4 **Prioritizing resource use for an application**



Limiting resource consumption

The following example describes a situation where a system administrator needs to limit resource consumption.

A system administrator has determined that screen savers displaying fractal designs consume as much CPU resource as permitted. To protect the system from these screen savers during the work day, the administrator creates a PRM group for them. This PRM group limits CPU consumption—when the system is at peak load—to 5%. When the system is not fully utilized, the screen savers can use the available CPU resources. Whenever the CPU cycles are needed for productive work, the screen savers cannot use more than 5% of the CPU resources.

Isolating resource use for applications and users

The following example describes a situation where a system administrator needs to isolate an application in order to ensure dedicated memory and CPU cycles.

A system administrator has determined that his company's credit card purchase system needs dedicated memory and CPU resources for users who are buying products. To ensure the buyers dedicated CPU cycles, the system administrator creates a PSET PRM group for buyers and assigns one of the system's four cores to the group. This guarantees the CPU cycles will be available to buyers as needed. In addition, the system administrator chooses the memory isolation option to prevent memory shares from being loaned out or borrowed from other groups. This ensures immediate response time, rather than waiting for borrowed memory to be paged back in.

2 Understanding how PRM manages resources

This chapter explains how PRM performs resource management. The following topics are covered:

- How PRM controls resources
- How PRM manages CPU resources
- How PRM manages real memory resources
- How resource allocations interact
- How PRM manages disk bandwidth resources
- How PRM manages applications

NOTE If PRM is unable to start or run properly due to CPU or memory resources not being available, it cannot manage your system's resources.

How PRM controls resources

PRM places limits on resource use based on values specified in a configuration file. These values always indicate a minimum amount and in some cases can indicate a maximum amount of a resource.

NOTE Do not use PRM with gang scheduling, which is the concurrent scheduling of multiple threads from a single process as a group (gang).

PRM groups

PRM groups are integral to how PRM works. These groups are assigned per process and are independent of any other groups, such as user groups that are defined in /etc/group. You assign applications and users to PRM groups. PRM then manages each group's CPU, disk bandwidth, and real memory resources (private and shared) according to the current configuration. If multiple users or applications within a PRM group are competing for resources, standard HP-UX resource management determines the resource allocation.

There are two types of PRM groups:

FSS PRM groups are the traditional and most commonly used PRM group. These groups have CPU, private memory, and disk bandwidth resources allocated to them using the shares model. (Shared memory is specified in megabytes.) FSS PRM groups use the Fair Share Scheduler in the HP-UX kernel within the system's default processor set (PSET).

PSET PRM groups are the second type of PRM group. In PSET PRM groups, the CPU entitlement is specified by assigning them a subset of the system's cores—instead of using the shares model. (A core is the actual data-processing engine within a processor. A single processor might have multiple cores. A core might support multiple execution threads, as explained in the section “Hyper-Threading” on page 49.) The private memory allocation is still specified in shares and shared memory is still in megabytes; however, the PSET PRM groups are treated as part of `PRM_SYS` (PRMID 0) for disk bandwidth purposes. Processes in a PSET PRM group have equal access to CPU cycles through the HP-UX time-share scheduler.

Because resource management is performed on a group level, individual users or applications may not get the resources required in a group consisting of many users or applications. In such cases, reduce the number of users and applications in the group or create a group specifically for the resource-intensive user or application.

Resource allocation

Resources are allocated to PRM groups differently depending on the resource and the type of PRM group. For FSS PRM groups, resources are typically allocated in shares. For PSET PRM groups, you allocate CPU resources using processor sets. Real memory resources are allocated in shares (private memory) or megabytes (shared memory). You cannot allocate disk bandwidth resources to PSET PRM groups.

What are processor sets?

Processor sets allow cores on your system to be grouped together in a set by the system administrator and assigned to a PSET PRM group. Once these cores are assigned to a PSET PRM group, they are reserved for use by the applications and users assigned to that group. Using processor sets allows the system administrator to isolate applications and users that are CPU-intensive, or that need dedicated on-demand CPU resources.

How processor sets work

Processor sets are a way of allocating dedicated CPU resources to designated applications and users. At system initialization time, a default PSET is created. This default PSET initially consists of all of your system’s cores. All FSS PRM group CPU allocation occurs in the default PSET. The system administrator can create additional PSET PRM groups and assign cores, applications, and users to those groups. Once cores are assigned to a PSET PRM group, they cannot be used by another group until a new configuration is loaded.

NOTE

When you have PRM groups based on PSETs enabled:

- Do not modify the PSETs manually using the `psrset` command
- Do not adjust CPU counts in virtual partitions using the `vparmodify` command
- Do not adjust Instant Capacity (iCAP), Temporary Instant Capacity (TiCAP), or Pay Per Use resources using the `icapmodify` or `ppuconfig` commands
- Do not perform online cell operations, using `parolrad` or any other interface, while PRM is managing the system (For more information, see the WARNINGS section in the prmconfig(1) manpage.)

Applications and users that are assigned to a PSET PRM group have dedicated CPU cycles from the cores assigned to the group. Competition for CPU cycles within the processor set are handled using the HP-UX time-share scheduler.

Table 2-1 shows a 16-core system that has four FSS PRM groups defined within the default PSET, and two additional system-administrator-defined PSET PRM groups. The default PSET contains eight cores, one of which is core 0. This is the only core that is required to be in the default PSET. The remaining cores in the default PSET are used by the `PRM_SYS`, `OTHERS`, `Dev`, `Appl` FSS PRM groups. There are two databases on this system that each have four cores assigned to them. Unlike the cores in the default PSET, the cores in the database PSET PRM groups are dedicated cores using the HP-UX time-share scheduler. This creates isolated areas for the databases.

Table 2-1 **Processor sets example**

PRM Group Type	Group Name	Core ID	Use
FSS PRM groups (Default PSET)	`PRM_SYS`, `OTHERS`, `Dev`, `Appl`	0, 1, 4, 5, 8, 9 12, 13	System processes, general users, and developers
PSET PRM group	`SalesDB`	2, 3, 6, 7	Sales database
PSET PRM group	`FinanceDB`	10, 11, 14, 15	Financial database

What are shares?

Resource shares are the minimum amounts of a resource assigned to each PRM group in a PRM configuration file (default name /etc/prmconf). For FSS PRM groups, you can assign CPU, disk bandwidth, and real memory shares, although only CPU share assignments are required. For PSET PRM groups, you can only assign real memory in shares. For both types of groups, you can also specify shared memory allocations.

In addition to minimum amounts, you can specify maximum amounts of of some resources that PRM groups can use. For FSS PRM groups, you can specify maximum amounts of CPU and memory resources. For PSET PRM groups, you can assign a maximum amount of memory; however, the maximum amount of CPU resources available to the PRM group is based on the number of cores assigned to the group. You can assign a maximum amount of memory to a PSET PRM group. These maximum amounts, known as caps, are not available for disk bandwidth for either type of PRM group. Shared memory allocations are static in size, so no caps are needed.

How shares work

A share is a guaranteed minimum when the system is at peak load. When the system is not at peak load, PRM shares are not enforced—unless `CPUCAPON` mode is enabled, in which case CPU shares are always enforced.

Valid values for shares are integers from one to `MAXINT` (the maximum integer value allowed for the system). PRM calculates the sum of the shares, then allocates a percentage of the system resource to each PRM group based on its shares relative to the sum.

Table 2-2 shows how shares determine CPU resource percentage. The total number of shares assigned is four. Divide each group's number of shares by four to find that group's CPU resource percentage. This CPU resource percentage applies only to those cores available to FSS PRM groups. If PSET PRM groups are configured, the cores assigned to them are no longer available to the FSS PRM groups. In such a case, the CPU resource percentage would be based on a reduced number of cores.

Table 2-2 **Converting shares to percentages**

PRM group	CPU shares	CPU resource %
`GroupA`	1	1/4 = 25.00%
`GroupB`	2	2/4 = 50.00%
`OTHERS`	1	1/4 = 25.00%

Shares allow you to add or remove a PRM group to a configuration, or alter the distribution of resources in an existing configuration, concentrating only on the relative proportion of resources and not the total sum. For example, assume we add another group to our configuration in Table 2-2, giving us the new configuration in Table 2-3.

To give the new group 50% of the available CPU resource, we assign it four shares, the total number of shares in the old configuration, thereby doubling the total number of shares in the new configuration.

Table 2-3 **Altered configuration**

PRM group	CPU shares	CPU resource percentage determined by PRM
`GroupA`	1	12.50%
`GroupB`	2	25.00%
`GroupC`	4	50.00%
`OTHERS`	1	12.50%

Hierarchical PRM groups

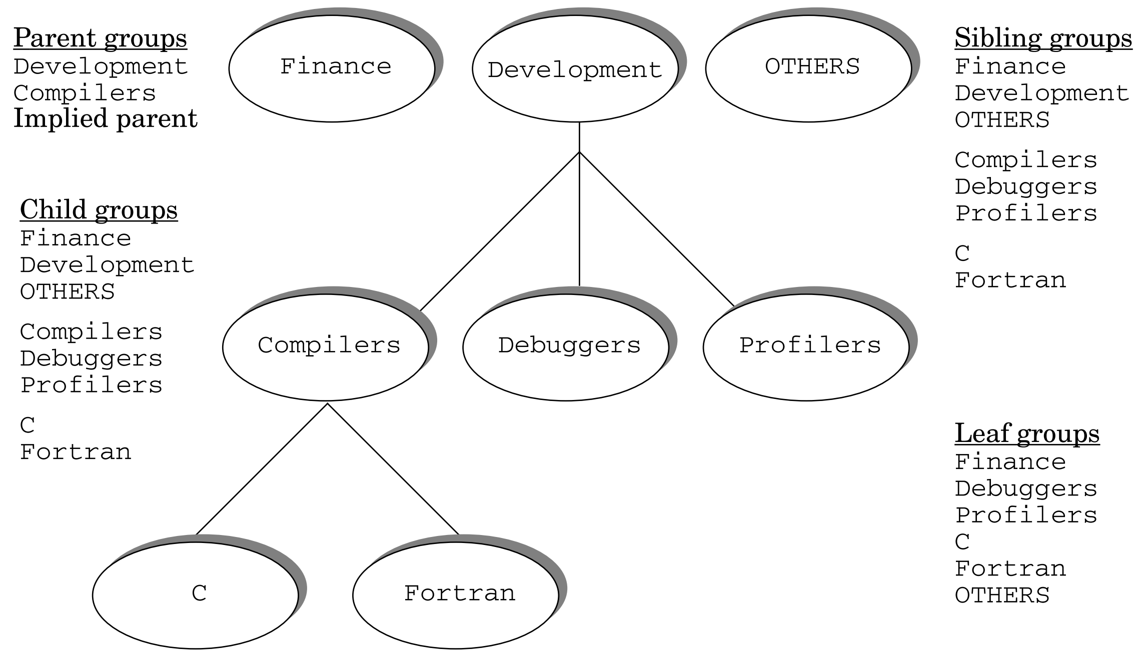
In addition to the flat divisions of resources presented so far, you can nest FSS PRM groups inside one another—forming a hierarchy of groups similar to a directory structure. Hierarchies allow you to divide groups and allocate resources more intuitively than you can with flat allocations. Note that PSET PRM groups cannot be part of a hierarchy.

When forming a hierarchy, any group that contains other groups is known as a parent group. Naturally, the groups it contains are known as child groups. All the child groups of the same parent group are called sibling groups. Any group that does not have child groups is called a leaf group.

There is also an implied parent group of all groups where the implied parent has 100% of the resource to distribute.

Figure 2-1 illustrates a configuration with hierarchical groups, indicating the parent, child, sibling, and leaf PRM groups.

Figure 2-1 **Parent, child, sibling, and leaf PRM groups**



In Figure 2-1, parent groups are the `Development` and `Development/Compilers` groups. There is also an implied parent group to the `Finance`, `Development`, and `OTHERS` groups. The `Development` group has the children `Development/Compilers`, `Development/Debuggers`, and `Development/Profilers`. The `Compilers` group is broken down further with two children of its own: `Development/Compilers/C` and `Development/Compilers/Fortran`. These two groups are also known as sibling groups. Leaf groups are groups that have no children. In the illustration above, leaf groups include the `Finance`, `Development/Debuggers`, and `OTHERS` groups, among others.

You specify resource shares for each group in a hierarchy. If a group has child groups, the parent group's resource shares are distributed to the children based on the shares they are assigned. If a group has no children, it uses the shares. More explicitly, the percentage that a group's shares equate to is determined as follows:

1. Start at the top level in the hierarchy. Consider these groups as sibling groups with an implied parent. This implied parent has 100% of the CPU resource to distribute. (Shares work the same way for CPU, private memory, and disk bandwidth resources.)
2. Add all the CPU shares of the first level of sibling groups together into a variable, `TOTAL`.
3. Each sibling group receives a percentage of CPU resources equal to its number of shares divided by `TOTAL`.
4. If the sibling group has no child groups, it uses the CPU resources itself.
5. If the sibling group does have child groups, the CPU resource are distributed further based on the shares assigned to the child groups. Calculate the percentages of the resource they receive by repeating items 2 through 5.

Consider the example in Table 2-4, which shows the PRM groups at the top-level.

Table 2-4 Hierarchical PRM groups—top level

Group	CPU shares	Percent of system's available CPU resources
`Finance`	3	30.00%
`Development`	5	50.00%
`OTHERS`	2	20.00%

Table 2-5 shows how the CPU resource percentages for the child groups of the `Development` group are determined from their shares. It also shows how the child groups for the `Development/Compilers` group further divide the CPU resources.

Table 2-5 Hierarchical PRM groups—`Development`'s child groups

Group	CPU shares	Percent of system's available CPU resources
`Development`	5	5/10 = 50.00% passed to child groups
`Development/Debuggers`	1	1/4 of its parent's CPU (50.00%) = 12.50% of system CPU
`Development/Profilers`	1	1/4 of its parent's CPU (50.00%) = 12.50% of system CPU
`Development/Compilers`	2	2/4 of its parent's CPU (50.00%) = 25.00% passed to child groups
`Development/Compilers/C`	4	4/8 of its parent's CPU (25.00%) = 12.50% of system CPU
`Development/Compilers/Fortran`	4	4/8 of its parent's CPU (25.00%) = 12.50% of system CPU

There is no requirement that the sum of the shares for a set of sibling groups be less than their parent's shares. For example, Table 2-5 shows the `Development/Compilers` group has 2 shares, while the sum of the shares for its child groups is 8. You can assign any group any number of shares between one and `MAXINT` (the system's maximum integer value), setting the proportions between groups as you consider appropriate.

The maximum number of leaf nodes is same as the maximum number of PRM groups you can have, which is 64 or 256 (starting with HP-UX 11i v2 Update 2).

NOTE Application records must assign applications only to leaf groups—not parent groups. Similarly, user records must assign users only to leaf groups. For more information on these record types, see “Controlling applications” on page 126 and “Specifying PRM users” on page 139.

In group/CPU records, each PRM group—regardless of where it is in the hierarchy—must be assigned resource shares.

Hierarchies offer a number of advantages, as explained below:

- Facilitates less intrusive changes—Similar to how shares in a flat configuration allow you to alter one record while leaving all the others alone, hierarchies enable you to alter the hierarchy in one area, leaving the rest unchanged.
- Enables you to use a configuration template—Create a configuration file that provides each department access to the system, then distribute the configuration and assign resources giving preference to certain departments on different machines.
- Allows continued use of percentages—If you prefer using percentages instead of shares, you can assign each level in the hierarchy only 100 resource shares.
- Facilitates giving equal access—If you want each PRM group to have equal access to a resource, simply assign each group the same number of shares. When you add a group, you do not have to recalculate resources and divide by the new number of groups; just assign the new group the same number of shares as the other groups. Similarly, removing a group does not require a recalculation of resources; just remove the group.
- Allows for more intuitive groups—Hierarchies enable you to place similar items together, such as all databases or a business entity/goal, and assign them resources as a single item.

- Enables making higher-level policy decisions—By placing groups in a hierarchy, you can implement changes in policy or funding at a higher level in a configuration without affecting all elements of the configuration.
- Facilitates system upgrades, capacity planning, and partitioning—If you are moving from a two-core system to a four-core system, you can reserve the two additional cores by adding a place-holder group at the top level in the hierarchy, assigning it shares equal to 50% of the CPU resources, and enabling capping. This place-holder prevents users from getting a boost in performance from the new cores, then being frustrated by poor performance when more applications are added to the system.

The syntax for hierarchical groups is explained in “Group/CPU record syntax” on page 105.

By default, PRM utilities (`prmconfig`, `prmlist`, `prmmonitor`) include only leaf groups in their output. Use the `-h` option to display information for parent groups as well.

How PRM manages CPU resources

This section describes how PRM manages CPU resources. To understand PRM’s CPU management, it is useful to know how the standard HP-UX scheduler works.

The HP-UX scheduler chooses which process to run based on priority. Except for real-time processes, the system dynamically adjusts the priority of a process based on resource requirements and resources used. In general, when processes are not running, the HP-UX scheduler raises their priorities; and while they are running, their priorities are lowered. The rate at which priority declines during execution is linear. The rate at which priority increases while waiting is exponential, with the rate of increase fastest when the CPU load is low and slowest when the CPU load is high. When a process other than the current process attains a higher priority, the scheduler suspends the current process and starts running the higher priority process.

Because the rate at which the priority increases is slowest when CPU load is high, the result is that a process with a heavy demand for CPU time is penalized by the standard HP-UX scheduler as its CPU resource use increases.

With PRM, you can reverse the effects of the standard scheduler. By placing users with greater demands for CPU resources in an FSS PRM group with a higher relative number of CPU shares than other groups, you give them a higher priority for CPU time. In a similar manner, you can assign an application to an FSS PRM group with a higher relative number of shares. The application will run in its assigned FSS PRM group, regardless of which user invokes it. This way you can ensure that critical applications have enough CPU resources. You can also isolate applications and users with greater demands for CPU resources by placing them in a PSET PRM group and assigning the desired number of cores to the group. The applications and users will have dedicated access to the cores in the PSET PRM group, ensuring CPU cycles when needed. This method of isolating applications and users effectively creates a partition on your system.

PRM manages CPU resources by using the fair share scheduler (FSS) for FSS PRM groups. When the PRM CPU manager is enabled, FSS runs for FSS PRM groups instead of the HP-UX standard scheduler. When PSET PRM groups are configured, FSS still runs for FSS PRM groups, but the standard HP-UX scheduler is used within PSET PRM groups.

PRM gives higher-priority FSS PRM groups more opportunities to use CPU time. Free CPU time is available for use by any FSS PRM group and is divided up between FSS PRM groups based on relative number of CPU shares. As a result, tasks are given CPU time when needed, in proportion to their stated importance, relative to others with a demand.

PRM itself has low system overhead.

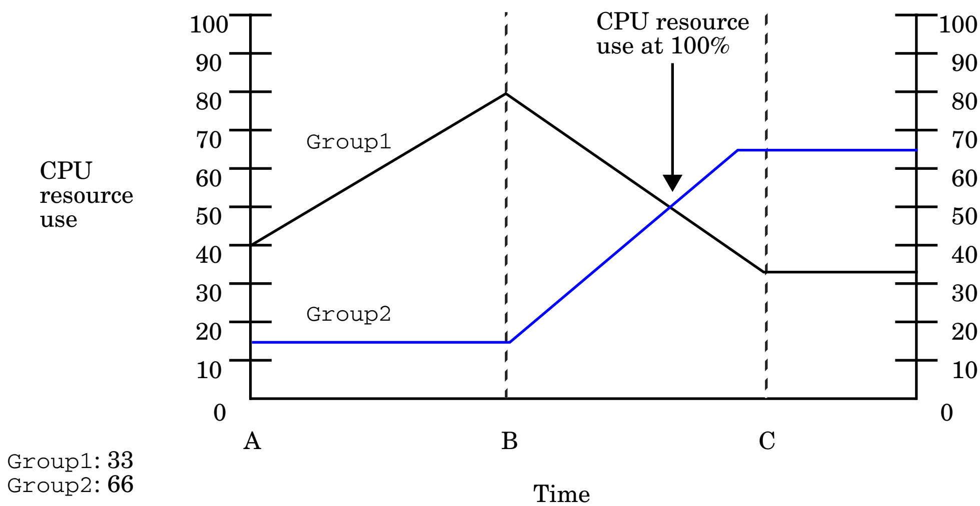
Example: PRM CPU resource management

Figure 2-2 illustrates PRM's CPU resource management for two FSS PRM groups.

In this example, `Group1` has 33 CPU shares, and `Group2` has 66 CPU shares.

Note that the percentage of CPU resources referred to may not be total system CPU resources if PSET PRM groups are configured. The percentage is of CPU resources available on the cores assigned to the default PSET. If PSET PRM groups are not configured, then the available CPU resources are the same as the system CPU resources.

Figure 2-2 **PRM CPU resource management**



At Time A:

- `Group1` is using 40% of the available CPU resources, which is more than its share.
- `Group2` is using 15% of the available CPU resources, which is less than its share.
- 45% of the available CPU resource are not used.
- PRM scheduling is not in effect.

At Time B:

- `Group1`'s processes are now using 80% of available CPU time, which consists of all of `Group1`'s shares and an unused portion of `Group2`'s share.
- `Group2` processes continue at a steady 15%.
- PRM scheduling is not in effect.

Between Time B and Time C:

- `Group2`'s demands start to increase.
- With available CPU resource use approaching 100%, PRM starts to have an effect on CPU allocation.
- Both groups' CPU resource use begins moving toward their assigned number of shares. In this case, the increasing demand of `Group2` causes `Group1` to be pulled toward the 33% mark despite its desire for more CPU resources.

At Time C:

- CPU resource use for `Group1` and `Group2` is limited to the assigned shares.

After Time C:

PRM holds each group to its assigned available CPU resource percentage until total available CPU resource demand is less than 100%. This gives `Group2` a priority for CPU resources over `Group1`. In contrast, in the standard HP-UX scheduler, CPU time is allocated based upon the assumption that all processes are of equal importance. Assuming there is one process associated with each PRM group, the standard HP-UX scheduler would allocate each process 50% of the available CPU resources after Time C.

CPU allocation and number of shares assigned

When managing FSS PRM groups, PRM favors processes in groups with a larger number of CPU shares over processes in groups with fewer CPU shares. Processes in FSS PRM groups with a larger number of CPU shares are scheduled to run more often and are given more opportunities to consume CPU time than processes in other FSS PRM groups. This preference implies that the process in an FSS PRM group with a larger number of shares may have better response times with PRM than with the standard HP-UX scheduler.

An FSS PRM group can use more than its configured CPU allocation when the system is at nonpeak load—unless `CPUCAPON` mode is enabled or a per-group cap equal to its allocation has been assigned. (For more information on capping options, see the next section, “Capping CPU resource use”.)

Capping CPU resource use

PRM gives you two options for capping CPU resource use by FSS PRM groups:

- On a per-group basis

  (Available for HP-UX 11i v3 and later.) For per-group capping, use the `MAX` field in the FSS PRM group record (discussed in the section “Group/CPU record syntax” on page 105) for only those groups you want to cap.

- For all FSS PRM groups in the configuration

  The `CPUCAPON` mode, enabled through the `prmconfig -M` option discussed below, treats the FSS PRM group’s minimum allocation as its maximum allocation.

  When `CPUCAPON` mode is enabled, CPU capping is in effect for all user-configured FSS PRM groups on a system—regardless of CPU load. Each FSS PRM group takes its entire CPU allocation. Thus, no group can obtain more CPU resources.

  The `PRM_SYS` group, however, is exempt from capping. If it gets CPU time and has no work, the PRM scheduler immediately goes to the next FSS PRM group.

NOTE Capping based on the `CPUCAPON` mode overrides per-group capping; however, using both forms of capping at the same time is not recommended.

For PSET PRM groups, capping is a result of the number of cores assigned to the group.

Capping CPU usage can be a good idea when migrating users and applications to a new system. When the system is first introduced, the few users on the system may become accustomed to having all of the machine's resources. However, by setting CPU caps early after the system's introduction, you can simulate the performance of the system under heavier use. Consequently, when the system becomes more heavily used, performance is not noticeably less. For information on capping CPU resource use, see "Specifying PRM groups/controlling CPU resource use" on page 104.

How PRM manages CPU resources for real-time processes

Although PRM is designed to treat processes fairly based upon their assigned shares, PRM does not restrict real-time processes. Real-time processes using either the POSIX.4 real-time scheduler (`rtsched`) or the HP-UX real-time scheduler (`rtprio`) keep their assigned priorities because timely scheduling is crucial to their operation. Hence, they are permitted to exceed their group's CPU share and cap. The CPU resources they use are charged to their groups. Thus, they can prevent other processes in their groups from running.

Hyper-Threading

Hyper-Threading, available starting with HP-UX 11i v3 (B.11.31), enables you to use multiple execution threads per core. Each execution thread is a logical CPU.

PRM supports the Hyper-Threading feature for PSET PRM groups. When PRM creates new PSETs, they inherit the Hyper-Threading state the system had before PRM was enabled. You can override the inherited state, specifying the desired state in the PRM configuration using the `PSET_ATTR` field in group records. For more information, see the section "Group/CPU record syntax" on page 105.

PRM sets the Hyper-Threading state for the default PSET, where FSS PRM groups are created, to optimize workload performance.

NOTE Do not change the value of a PSET's LCPU attribute, using either `psrset` or `kctune`, while PRM is running.

Multiprocessors and PRM

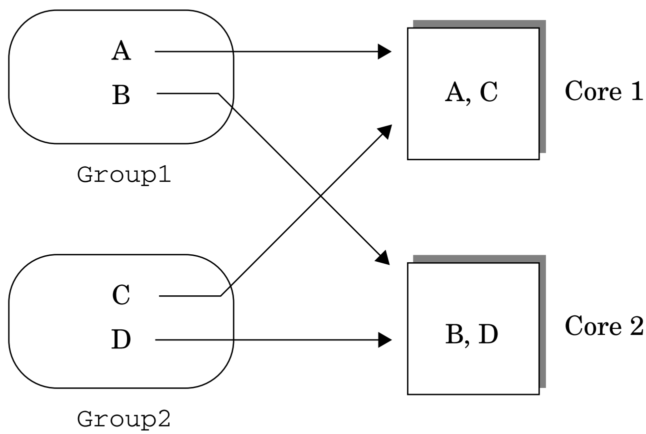
PRM takes into account architectural differences between multiprocessor (MP) and single-processor systems.

In the case of memory management, Hewlett-Packard multiprocessor systems share the same physical address space. Therefore PRM memory management is the same as on a single-processor system.

However, in the case of CPU resource management, PRM makes accommodations for MP systems. The normal HP-UX scheduling scheme for MP systems keeps the CPU load average at a uniform level across the cores. PRM tries to even the mix of FSS PRM groups on each available CPU. (With Hyper-Threading disabled, each core is seen as a CPU. With Hyper-Threading enabled, each core can be seen as multiple, logical CPUs.) This is done by assigning each process in an FSS PRM group to a different CPU, stepping round-robin through the available CPUs, with the CPUs being cores or logical CPUs depending on whether Hyper-Threading is enabled. Only processes that can be run or processes that are likely to run soon are actually assigned in this manner.

For example, on a two-way MP system with Hyper-Threading disabled, FSS PRM `Group1` has two active processes A and B, and FSS PRM `Group2` has two active processes C and D. In this example, PSET PRM groups are not configured. PRM assigns process A to the first core, process B to the second core, process C to the first core, and finally process D to the second core—as shown in Figure 2-3.

Figure 2-3 **PRM's process scheduling on MP systems (Hyper-Threading disabled)**



If a process is locked down on a particular core, PRM does not reassign it, but does take it into account when distributing other processes across the cores. PRM manages the CPU resource only for the cores on a single system; it cannot distribute processes across cores on different systems.

As implied above, PRM provides a PRM group its entitlement on a symmetric-multiprocessing (SMP) system with Hyper-Threading disabled by granting the group its entitlement on each core. If the group does not have at least one process for each core, PRM compensates by proportionally increasing the PRM group's entitlements on cores where it does have processes. For example, a PRM group with a 10% entitlement on a 4-core system, gets 10% of each core. If the group is running on only one core because it has only one process, the 10% entitlements from the three unused cores are given to the group on the core where it has the process running. Thus, it gets 40% on that one core.

NOTE A PRM group on a system with Hyper-Threading disabled may not be able to get its entitlement because it has too few processes. For example, if the PRM group above—with only one single-threaded process—were to have a 50% entitlement for the 4-core system, it would never get its entitlement. PRM would give the group an entitlement of 100% on two cores. However, because the group has only the one thread, it can use only one core—resulting in a 25% entitlement.

How PRM manages real memory resources

Memory management refers to the rules that govern real and virtual memory and allow for sharing system resources by user and system processes.

In order to understand how PRM manages real memory (both private and shared), it is useful to understand how PRM interacts with standard HP-UX memory management.

How HP-UX manages memory

The data and instructions of any process (a program in execution) must be available to the core by residing in real memory at the time of execution. Real memory is shared by all processes and the kernel.

To execute a process, the kernel executes through a per-process virtual address space that has been mapped into real memory. Memory management allows the total size of user processes to exceed real memory by using an approach termed demand-paged virtual memory. Virtual memory enables you to execute a process by bringing into real memory parts of the process only as needed and pushing out parts of a process that have not been recently used.

The system uses a combination of paging and swapping to manage virtual memory. Paging involves writing unreferenced pages from real memory to disk periodically.

Swapping takes place if the system is unable to maintain a large enough free pool of memory. In such a case, entire processes are swapped. The pages associated with these processes can be written out by the pager to secondary storage over a period of time.

The more real memory a system has available, the more data it can access and the more (or larger) processes it can execute without having to page or cause swapping.

Available memory

A portion of real memory is always reserved for the kernel (/stand/vmunix) and its data structures, which are dynamically allocated. In addition, memory is reserved for nonkernel system processes. The amount of real memory that remains is available for user processes. This memory is known as available memory and is the memory amount reported by `prmavail`. Available memory varies over time. Because the size of the kernel varies depending on the number of interface cards, users, and values of the tunable parameters, available memory varies from system to system.

For example, Table 2-6 shows a system with 1024 Mbytes of physical memory. Approximately 112 Mbytes of that memory is used by the kernel and its data structures, leaving 912 Mbytes of memory available for all processes, including system processes. In this example, 62 Mbytes are used by system processes, leaving 850 Mbytes of memory available for user processes. PRM reserves 11% of the remaining memory in the example to ensure processes in `PRM_SYS` have immediate access to needed memory. Although you cannot initially allocate this reserve to your PRM groups, it is still available for your PRM groups to borrow from when needed. So, in this example, the `prmavail` command would show 850 Mbytes of available memory before PRM is configured, and 756 Mbytes of available memory after PRM is configured.

Table 2-6 **Example of available memory on a 1024-Mbyte system**

Mbyte	Memory type
1024	Physical memory available on the system
912	Memory available for all processes
850	Memory available for user processes
756	Memory available after PRM is configured

How PRM controls memory usage

PRM memory management allows you to prioritize how available memory is allocated to user and application processes. This control enables you to ensure that critical users and applications have enough real memory to make full use of their CPU time.

When PRM first starts and is configuring memory management, the `PRM_SYS` group (PRMID 0) is in control of all usable memory on the system. The memory not needed by processes in `PRM_SYS`, known as available memory, is the memory reported by `prmavail`. This remaining memory is allocated to the other PRM groups, according to their entitlements. The amount of available memory may fluctuate up or down based on the needs of the kernel, buffer cache, daemons, and other processes in `PRM_SYS`.

PRM's memory management is controlled by the daemon `prm2d`. This daemon uses an in-kernel memory feature to partition memory (when a configuration is loaded), with each PRM group getting a partition. Each partition includes *x* Mbytes of memory, where *x* Mbytes is equivalent to the group's entitled percent of the available memory or the requested, fixed-size shared memory allocation. Each partition pages separately.

When system memory use is not at 100%, a PRM group that does not have its memory use capped or isolated can freely borrow excess memory pages from other PRM groups. If a process requires memory and its memory use is capped, processes in the same PRM group as the original process are forced to page to free up memory.

When system memory use is at 100%, borrowed memory pages are returned to the owning PRM groups if needed. The time involved for the borrowed memory pages to be returned is dependent on the swap rate and the order in which old pages are paged out.

If a group is exceeding its memory shares on a system that is paging, `prm2d` uses proportional overachievement logic. Overachievement for a group is the ratio of memory used to memory entitlement. This value is then compared to the average overachievement of all groups. If a PRM group is overachieving compared to the average, then the number of import pages for that group is reduced. This allows other groups to start importing the newly available memory.

Groups are not allowed to exceed their memory caps.

NOTE When an initial configuration requesting memory management is loaded (after installing or resetting PRM), PRM initializes memory resource groups (MRGs) giving all usable memory to `PRM_SYS` initially. Any free memory is then distributed to other PRM groups. This distribution of memory for use by your PRM groups can be affected by:

- Heavy paging or swapping
- A single application using over half the lockable memory on the system

Such conditions may exist if memory-intensive applications start immediately after PRM is configured—as may be the case with applications starting automatically at reboot.

You can possibly avoid these issues by:

- Starting these applications in their designated PRM groups with the `prmrun` command
- Using the `PRM_SLEEP` variable in your /etc/rc.config.d/prm file so that the application manager and memory manager can place processes in their configured groups before the heavy demand begins.

Reducing memory shares

If a PRM group's memory share is reduced while the group is using most of its memory pages, the reduction is not immediately visible. The memory must be paged out to the swap device. The time involved for the reduction to take effect is determined by the memory transfer rate (for example, 2 Mbytes/second), and the order in which the old pages are paged out.

Therefore, when changing shares, give them time to take effect before implementing new shares again.

Capping memory use

You can optionally specify a memory cap for a PRM group. This cap is a hard upper bound: a PRM group cannot exceed its memory cap. Typically, you might choose to assign a memory cap to a PRM group of relatively low priority, so that it does not place excessive memory demands on the system. For information on setting a memory cap, see "Controlling memory use" on page 113.

Implementation of shares and caps

In addition to specifying memory shares (a lower bound) for private memory, you can optionally specify a memory cap (upper bound) for a PRM group.

It is important to note the difference between memory shares and a memory cap. Shares guarantee the minimum amount of real memory that a group is allowed to consume at times of peak system load. The memory cap is an upper bound.

Isolating a group's private memory resources

In addition to specifying private memory shares, the `prm2d` memory manager allows you to optionally specify a group's private memory resources to be restricted from use by other groups and processes on the system. This type of restriction is called memory isolation.

When a group's memory shares are isolated, those memory shares cannot be loaned out to other groups. Memory isolation also means that memory cannot be borrowed from other groups.

PRM allows groups that do not have memory isolation enabled to freely borrow memory from other groups as needed. The lending groups are restricted in their giving by their physical entitlement size. A group cannot lend its memory resources if memory isolation is enabled.

Memory isolation can be useful for applications that need dedicated memory resources, or that tune their own memory needs based on their fixed allocation of resources.

How PRM manages shared memory

By default, all shared memory is allocated in the `PRM_SYS` group.

Starting with HP-UX 11i v2 Update 2 and PRM C.03.01, PRM can control shared memory allocations on a PRM group basis. You only control shared memory for the groups that need it—you can omit control for groups where shared memory control would not be helpful.

PRM does not allow borrowing or lending of shared memory as it is not beneficial. Similarly, capping is not available for shared memory. You set a minimum size in megabytes for a group’s shared memory allocation. (This allocation size is usually available from the configuration settings for the consuming application, as is the case with the Oracle SGA size.)

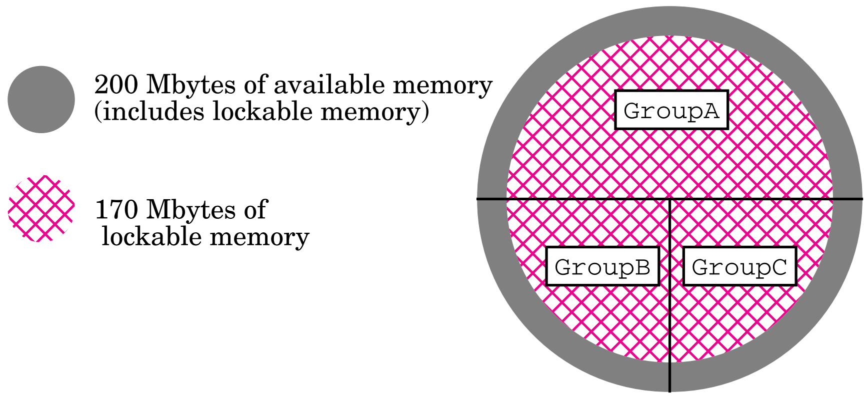
How PRM manages locked memory

Real memory that can be locked (that is, its pages kept in memory for the lifetime of a process) by the kernel, by the `plock()` system call, or by the `mlock()` system call, is known as lockable memory.

Locked memory cannot be paged or swapped out. Typically, locked real memory holds frequently accessed programs or data structures, such as critical sections of application code. Keeping them memory-resident improves system performance. Lockable memory is extensively used in real-time environments, like hospitals, where some processes require immediate response and must be constantly available.

Locked memory is distributed based on the assigned memory shares. For example, assume a system has 200 Mbytes of available memory, 170 Mbytes of which is lockable. Lockable memory divided by available memory is 85%. If `GroupA` has a 50% memory share, it gets 100 Mbytes of real memory. Of that amount, 85% (or 85 Mbytes) is lockable. Notice that 85 Mbytes/170 Mbytes is 50%, which is the group’s memory share. Figure 2-4 illustrates this idea.

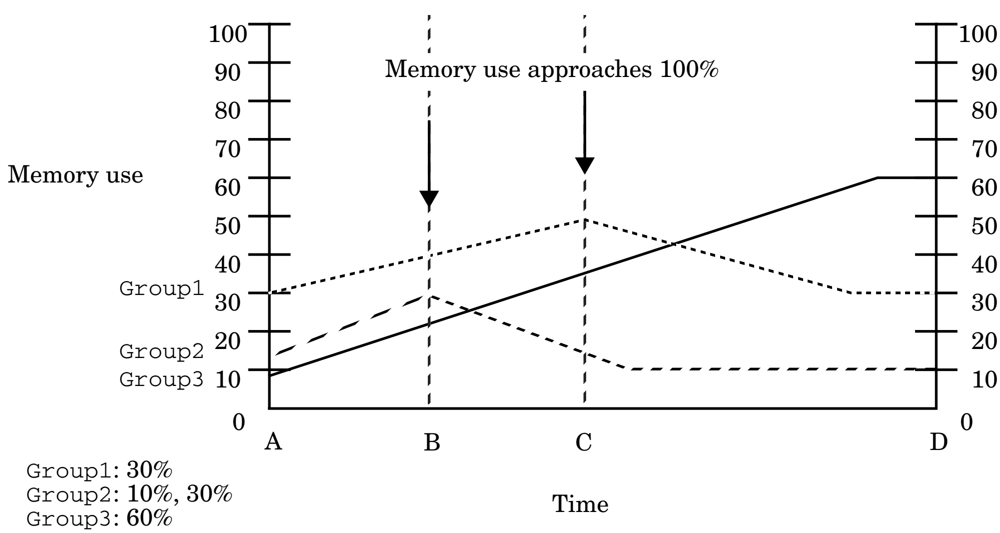
Figure 2-4 **Locked memory distribution**



Example: memory management

This example shows how the PRM memory manager `prm2d` manages the competing memory demands of three PRM groups as system memory utilization approaches 100%.

Figure 2-5 **Memory management**



At Time A

- There is plenty of memory available on the system for the processes that are running.
- `Group1` is using its share, and `Group2` is using slightly more than its share, borrowing excess from `Group3`.
- `Group3` is using much less than its share.

At Time B:

- System memory use approaches 100%.
- `Group1` is borrowing excess memory from `Group3`.
- `Group2` processes reach the group's 30% memory cap. Consequently, `Group2`'s processes are forced to page, causing a performance hit.

Between Time B and Time C, `Group3`'s demands continue to increase.

At Time C:

- System memory use is near 100%.
- `Group3` is not getting sufficient memory and needs its loaned-out memory back. PRM then determines which groups are overachieving with respect to their memory entitlement. In this case, the increasing demand of `Group3` causes `Group1` and `Group2` to be pulled toward their shares of 30% and 10% respectively despite their desire for more memory. `Group3` is allowed to freely consume up to 60% of available memory, which it reaches at Time D.

After Time D:

PRM now holds each group to its entitled memory percentage. If a group requests more memory, the request is filled with pages already allocated to the group.

How resource allocations interact

You can assign different numbers of shares for CPU (for FSS PRM groups), memory, and disk bandwidth resources to a PRM group depending on the group's requirements for each type of resource. To optimize resource use, it is important to understand the typical demands for resources within a PRM group.

For example, suppose the DesignTool application is assigned to PRM group `DTgroup`, and it is the only application running in that group. Suppose also that the DesignTool application uses CPU and memory resources in an approximate ratio of two to three. For optimal results, you should assign the resource shares for `DTgroup` in the same ratio. For example, assign 10 CPU shares and 15 memory shares or 20 CPU shares and 30 memory shares.

If the percentages assigned do not reflect actual usage, then a PRM group may not be able to fully utilize a resource to which it is entitled. For instance, assume you assign 50 CPU shares and 30 memory shares to `DTgroup`. At times of peak system load, `DTgroup` is able to use only approximately 20 CPU shares (although it is assigned 50 shares) because it is limited to 30 memory shares. (Recall that DesignTool uses CPU and memory resources at a ratio of two to three.) Conversely, if `DTgroup` is assigned 10 CPU shares and 30 memory shares, then at times of peak system load, `DTgroup` is only able to utilize 15 memory shares (not its 30 shares), because it is restricted to 10 CPU shares.

To use system resources in the most efficient way, monitor typical resource use in PRM groups and adjust shares accordingly. You can monitor resource use with the `prmanalyze` command, the `prmmonitor` command, or the optional HP product GlancePlus. For more information on `prmmonitor`, see the prmmonitor(1) manpage.

For `prmanalyze` syntax information, see the section "`prmanalyze`" on page 203. For usage examples, see "Using `prmanalyze` to quickly identify resource use" on page 81 and "Using `prmanalyze` to analyze your configuration" on page 162.

How PRM manages disk bandwidth resources

PRM manages disk bandwidth at the logical volume group/disk group level. As such, your disks must be mounted and under the control of either HP's Logical Volume Manager (LVM) or VERITAS Volume Manager™ (VxVM®) to take advantage of PRM disk bandwidth management. PRM controls disk bandwidth by re-ordering the I/O requests of volume groups and disk groups. This has the effect of delaying the I/O requests of low-priority processes and accelerating those of higher-priority processes.

NOTE Disk bandwidth management works only when there is contention for disk bandwidth, and it works only for actual I/O to the disk. (Commonly, I/O on HP-UX is staged through the buffer cache to minimize or eliminate as much disk I/O as possible.) Also, note that you cannot allocate disk bandwidth shares for PSET PRM groups. PSET PRM groups are treated as part of `PRM_SYS` (PRMID 0) for disk bandwidth purposes.

Disk bandwidth management works on disk devices, stripes, and disk arrays. It does not work on tape or network devices.

When you change share allocations on a busy disk device, it typically takes 30 seconds for the actual bandwidth to conform to the new allocations.

Multiple users accessing raw devices (raw logical volumes) will tend to spend most of their time seeking. The overall throughput on this group will tend to be very low. This degradation is not due to PRM's disk bandwidth management.

When performing file system accesses, you need approximately six disk bandwidth consumers in each PRM group before I/O scheduling becomes noticeable. With two users, you just take turns. With four, you still spend a lot of your time in system call overhead relative to the peak device bandwidth. At six, PRM disk bandwidth management begins to take effect. The more demand you put on the system, the closer the disk bandwidth manager approaches the specified values for the shares.

For more information about LVM or about using PRM disk bandwidth management, see “Setting up your disks” on page 85.

How PRM manages applications

This section describes how PRM assigns processes to run in PRM groups. The following topics are discussed:

- How application processes are assigned to PRM groups at start-up
- How PRM handles child processes
- Pattern matching for filenames
- Pattern matching for renamed application processes
- Precedence of PRM group assignments

When an application is started, it runs in the initial PRM group of the user that invoked it. If the application is assigned to a PRM group by a record in the configuration file, the application manager soon moves the application to its assigned group. A user who does not have access to an application’s assigned PRM group can still launch the application as long as the user has execute permission to the application. An application can be assigned to only one PRM group at a time. Child processes inherit their parent’s PRM group. Therefore, all the application’s child processes run in the same PRM group as the parent application by default.

You can explicitly place an application in a PRM group of your choosing with two commands. Use the `prmmove` command to move an existing application to another group. Use the `prmrun` command to start an application in a specified group.

These rules may not apply to processes that bypass `login`. See the section “Special case of interest: Client/server connections” on page 198 for more details.

How application processes are assigned to PRM groups at start-up

Table 2-7 describes what PRM groups an application process is started in based on how the application is started.

Table 2-7 PRM's group assignments at process start-up

Process initiated	Process runs in PRM group as follows
By user By `at` By `cron` Upon login	Process runs in the user's initial group. If the user does not have an initial group, the process runs in the user default group, `OTHERS`. (If the process has a compartment record, an application record, or a Unix group record, it still starts in the invoking user's initial group. However, the application manager will soon move the process to its assigned group—with compartment records taking precedence over application records, which take precedence over Unix group records.)
By `prmrun` {`-g` *`targetgrp`* | `-i`}	Process runs in the PRM group specified by *`targetgrp`* or in the user's initial group. The PRM application manager cannot move a process started in this manner to another group.
By `prmrun` *`application`* (`-g` *`targetgrp`* is not specified)	Process runs in the application's assigned PRM group. If the application does not have a group, an error is returned.
By `prmmove` {*`targetgrp`* | `-i`}	Process runs in the PRM group specified by *`targetgrp`* or in the user's initial group. The PRM application manager cannot move a process started in this manner to another group.
By another process	Process runs in the parent process's group.

How PRM handles child processes

When they first start, child processes inherit the PRM groups of their parent processes. At configurable polling intervals, the application manager checks the PRM configuration file against all processes currently running. If any processes should be assigned to different PRM groups, the application manager moves those applications to the correct PRM groups.

If you move a parent process to another PRM group (with the `prmmove` command), all of its child processes remain in the original PRM group. If the parent and child processes should be kept together, move them as a process group or by user login name.

Pattern matching for filenames

Application filenames in application records can contain pattern matching notation as described in the regexp(5) manpage. This feature allows you to assign all appropriate applications that reside in a single directory to a PRM group—without creating an application record for each individual application.

The wildcard characters (`[`, `]`, `*`, and `?`) can be used to specify application filenames. However, these characters cannot be used in directory names.

To assign all the applications in a directory to a PRM group, create an application record similar to the following, with the filename specified only by an asterisk (`*`):

```
/opt/special_apps/bin/*::::GroupS
```

Filenames are expanded to their complete names when a PRM configuration is loaded. Explicit application records take precedence over application records that use wildcards. If an application without an explicit record is matched by several records that use pattern matching, the record closest to the beginning of the configuration file is used.

Pattern matching for renamed application processes

Alternate names specified in application records can also contain pattern matching notation as described in the regexp(5) manpage.

NOTE Use pattern matching only when it is not practical to list all possible alternate names.

Many complex applications, such as database applications, may assign unique names to new processes or rename themselves while running. For example, some database applications rename processes based on the database instance, as shown in this list of processes associated with a payroll database instance:

```
db02_payroll
db03_payroll
db04_payroll
dbsmon_payroll
dbwr_payroll
dbreco_payroll
```

To make sure all payroll processes are put in the same PRM group, use pattern matching in the alternate names field of the application record, as shown below:

```
/usr/bin/database:::business_apps,db*payroll
```

For alternate names and pattern matching to work, the processes must share the same file ID. (The file ID is based on the file system device and the file's inode number.) PRM performs this check to make sure that only processes associated with the application named in the application record are put in a configured PRM group.

If there are multiple application records with alternate names that match an application name due to redundant pattern matching resolutions, the "first" record to match the application name takes precedence. For example, the application `abb` matches both of the following application records:

```
/opt/foo/bin/bar:::GroupA,a*
/opt/foo/bin/bar:::GroupB,*b
```

Because the `*b` record is first (based on ASCII dictionary order), the application `abb` would be assigned to the PRM group `GroupB`.

You can also use an Extended Regular Expression, or ERE, as the alternate name in an application record. (For more information, refer to the EXTENDED REGULAR EXPRESSION section in regexp(5)). If you do so, the ERE should be the only alternate name in the record, and it should be within single quotes. Other records can still have non-ERE alternate names for the same application. Note that while non-ERE alternate names are matched against non-dash command-line arguments, Extended Regular Expression alternate names are matched against the entire available command line. Note that commas within an ERE are not separators for alternate names; they must match commas in the command line.

NOTE You cannot use colons in an ERE, as PRM uses colons for field separators.

If an ERE alternate name and a non-ERE alternate name both exist for the same application, the non-ERE alternate name takes priority. If multiple ERE alternate names match, the “first” record to match takes precedence. For example, the application abb matches both of the following application records:

```
/opt/foo/bin/bar:::GroupA,'a.*'
/opt/foo/bin/bar:::GroupB,'.*b'
```

Because the `'.*b'` record is first (based on ASCII dictionary order), the application `abb` would be assigned to the PRM group `GroupB`.

Knowing the names of all the processes spawned and renamed by the applications can help in creating pattern matching that is only as general as it needs to be. Eliminate redundant name resolutions whenever possible, and make sure pattern matching does not cause unwarranted moves.

For information on how alternate name pattern matching affects precedence, see the next section, “Precedence of PRM group assignments.”

Precedence of PRM group assignments

The PRM application manager checks that applications are running in the correct PRM groups every *`interval`* seconds. The default *`interval`* is 30 seconds; however, you can change it as explained in the section “Setting the application manager’s polling interval” on page 181.

The precedence of PRM record types—from highest to lowest—is:

1. Compartment record
2. Application record
3. User record
4. Unix group record

The PRM application manager goes through the following steps to determine in which PRM group to place a process.

1. Manually moved processes

   Leave manually moved processes (processes moved using `prmrun` or `prmmove`) in their current PRM groups.

2. Compartment records

   Move a process running in a secure compartment that is mapped to a PRM group using a compartment record to the assigned PRM group.

3. Application records

   If the file ID of the process matches the file ID for the full pathname of any application listed in an application record in the current configuration, make the following checks:

   a. If the process name is an exact match of an alternate name given in the application record, move the application to the PRM group assigned in the record.

   b. If the process name matches any of the alternate names specified by pattern (regular expression) in application records, then:

      - If it matches only one alternate name, move it to the PRM group specified in that record.
      - If it matches multiple alternate names specified by pattern, move the process to the PRM group specified in the "first" matching record.

        The "first" matching record is determined by sorting the alternate names specified by pattern in lexicographical (ASCII dictionary) order.

   c. Move the process to the PRM group specified in the application record that has no alternate name.

4. Root processes

   Move any process running as root to the PRM_SYS group (or to root's initial group if explicitly given in a user record).

5. User records

   Move any process run by a nonroot user to the initial group assigned to the user in a user record, assuming the initial group is other than (NONE).

6. Unix group records

   If a record exists for the effective group ID of the process and the record indicates a PRM group other than (NONE), move the process to the indicated PRM group.

7. Move the process to the OTHERS group.

To illustrate these rules, consider the following application records:

```
/bin/call_home:::GroupA
/bin/cal*:::GroupB
/bin/cal:::GroupC
/bin/c*:::GroupD
/bin/call_home:::GroupE,phone_home,tele*_home
/opt/foo/bin/bar:::GroupF
/opt/foo/bin/bar_none:::GroupG
/bin/call_home:::GroupZ,*home
```

Assume a user starts an application, my_favorite_app, without using prmrun:

```
% my_favorite_app
```

Because the application does not have an application record, it does not meet any of the criteria above and starts in the invoking user's PRM group.

Now assume the user starts the bar_none application, which has a record, but is started in a group specified using prmrun.

```
% prmrun -g GroupA bar_none
```

In this case, the application manager determines that the application has been moved manually and leaves it as is, in GroupA.

Next, assume the user launches the `bar` application, which also has an application record.

```
% bar
```

The application starts in the invoking user's initial group. However, the application manager will soon place the application in the group specified in the application record, `GroupF`.

The user then starts another program:

```
% phone_home
```

This application name is an exact match of an alternate name. If `phone_home` has the same file ID as `/bin/call_home`, the `phone_home` process is placed in `GroupE`.

Another user on the system starts a program:

```
% telegraph_home
```

This application name matches two alternate names, both specified using regular expressions: `tele*_home` and `*home`. Sorting based on the ASCII dictionary, the application matches `*home` first. Assuming `telegraph_home` has the same file ID as `/bin/call_home`, it is placed in `GroupZ`.

Starting one more program:

```
% call_home
```

The `call_home` command is matched by the first and eighth records. (The second and fourth records do not match because PRM expands the regular expressions when the configuration is loaded and finds `call_home` already has a record.) The eighth record takes precedence because it has an alternate name, and the `call_home` process is placed in `GroupZ`.

NOTE

Be careful when constructing regular expressions: As shown with the eighth record above, an expression that is not specific enough can override explicit application records.

Lastly, a user starts the following program:

```
% calendar
```

The second and fourth records both seem to match the `calendar` command. The expressions are expanded in the order they appear in the configuration file. So, the second record is expanded first and is used for the `calendar` process, placing it in `GroupB`.

3 PRM configuration planning

This chapter focuses on determining your PRM configuration needs. It explains:

- Using multiple configurations
- Selecting a configuration model
- Identifying resource use
- Using `prmanalyze` to quickly identify resource use

Using multiple configurations

Because PRM is configured using files, you can maintain numerous configurations using multiple configuration files. These files are normally stored in the directory /etc/opt/prm/conf/, with the owner set to hpsmh. You can then change your configuration at a particular time of day, on a certain day of the week, or on any other schedule you can specify using the `cron` command.

As you read about the configuration models discussed in this chapter, remember that you can change between the models by using multiple configuration files.

Specify a configuration file other than the default /etc/prmconf with the `-f` *`configfile`* option to `prmconfig` or by selecting the alternate file in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager. For more information, see the section "`prmconfig`" on page 210 or the online help.

Selecting a configuration model

Your PRM configuration should reflect some aspect of your business priorities. You may choose to configure your system based on how much each user group funds the system (budget model). Alternatively, you may configure the system to reflect the priorities of the applications that run on it (application priority model). Perhaps, you will devise another configuration model.

In general, when planning a PRM configuration, you should determine:

1. Your total available memory, number of cores, number and throughput speed of disks.
2. Who the users are and what their needs are.

Whatever model you choose, it is important to identify the configuration model you want before you begin to identify resource use and assign PRM groups and resource allocations.

Budget model configurations

In a budget model configuration, you create PRM groups and assign resource allocations that reflect the funding each department provides for the system.

For example, suppose there are three departments using one four-core system:

- Department A with five users
- Department B with three users
- Department C with two users

If each department provides equal funding per user, a budget model configuration for PRM might result in:

- User default group for guests and system administrator:
  5 CPU shares, 5 memory shares, 5 disk bandwidth shares
- Group A: 50 CPU shares, 50 memory shares, 50 disk bandwidth shares
- Group B: 30 CPU shares, 30 memory shares, 30 disk bandwidth shares
- Group C: 20 CPU shares, 20 memory shares, 20 disk bandwidth shares

NOTE Although the preceding example shows CPU, memory, and disk bandwidth resources allocated equally within each group, there is no requirement that these resource shares be equal.

If the funding from each department is done equally per department regardless of the number of users, then an alternate budget model configuration for PRM might result in the following allocations:

- User default group for guests and system administrator:
  5 CPU shares, 5 memory shares, 5 disk bandwidth shares
- Group A: 50 CPU shares, 50 memory shares, 50 disk bandwidth shares
- Group B: 50 CPU shares, 50 memory shares, 50 disk bandwidth
- Group C: 50 CPU shares, 50 memory shares, 50 disk bandwidth shares

Another way of allocating the computing resources equally is to assign each department to an isolated area using PSET PRM groups. In the following example, each department is allocated its own core for CPU cycles. Memory is allocated equally using shares, and disk bandwidth is obtained for the PSET PRM groups from `PRM_SYS`.

- User default group for guests and system administrator: 5 CPU shares, 5 memory shares, 5 disk bandwidth shares
- Group A: Core 1, 50 memory shares
- Group B: Core 2, 50 memory shares
- Group C: Core 3, 50 memory shares

In the above example, you can also equally allocate memory shares using memory isolation. The isolated groups will use only their entitlements. They will not loan out or borrow memory from other groups.

NOTE Although the preceding example shows each department receiving one core each, there is no requirement that these PSET PRM groups allocate the same number of cores to each department. Core 0, however, is reserved for FSS PRM groups within the default PSET.

Application priority model configurations

In an application priority model configuration, you create PRM groups and assign allocations that reflect the relative importance of the application to your business as well as the resource needs of the application. You can use tools such as `prmanalyze`, `acctcom`, and HP's GlancePlus to help you plan your configuration.

For example, suppose you have three departments that use a system. You have analyzed this system over a period of time and observed the following list in order of descending priority:

- The sales department with five users running:
  - Order process application
  - Word processing and miscellaneous tasks
  - Mail application

- The planning department with three users running:
  — Inventory application
  — Word processing and miscellaneous tasks
  — Mail application
- The development department with two users running:
  — CAD design tool
  — Debugging tools
  — Compilers
  — Word processing and miscellaneous tasks
  — Mail application

Table 3-1 shows how much CPU and memory resources each application is using.

Table 3-1 CPU and memory resource usage

Application	Sales CPU, MEM	Planning CPU, MEM	Development CPU, MEM	Total CPU use	Total memory use
Mail	5%, 2%	3%, 2%	2%, 1%	10%	5%
Word processing and miscellaneous	5%, 2%	10%, 5%	5%, 3%	20%	10%
Order processing	20%, 15%	-	-	20%	15%
Inventory	-	10%, 15%	-	10%	15%
Design tool	-	-	10%, 30%	10%	30%
Debugging tools	-	-	10%, 10%	10%	10%
Compilers	-	-	20%, 15%	20%	15%

A resulting application priority configuration might be:

- Mail group (mail):
  10 CPU shares, 5 memory shares
- User default group, word processing, and miscellaneous:
  20 CPU shares, 10 memory shares
- Business applications group (order processing, inventory):
  30 CPU shares, 30 memory shares
- Development tools group (design tool, debugger, compilers):
  40 CPU shares, 55 memory shares

In this configuration, business applications are assigned to the business applications group, and development tools are assigned to the development tools group. These two groups are given a relatively large number of CPU and memory shares to ensure sufficient resources for the critical applications during times of heavy system demand. Lower priority word processing and miscellaneous tasks are run in the user default group, which has a small number of CPU and memory shares. Mail, assigned to a separate group, is restricted to 10 CPU shares and 5 memory shares during times of heavy system demand.

The work-load distribution can be refined further. If an application launches processes, the new processes can be moved to different PRM groups. Thus, a database program that launches several instances, for example, an inventory database and an order processing database, can have more CPU and memory assigned to the order processing database. Create another group to give order processing the 20 CPU shares it needs during peak processing times, and assign processes associated with the order processing database to the new PRM group. Assign these processes using an application record that has "`order *`" in the alternate name field. The application manager moves the processes shortly after they are started by the main database application. The new application priority would be:

- Mail group (mail): 10 CPU shares, 5 memory shares
- User default group, word processing, and miscellaneous:
  20 CPU shares, 10 memory shares
- Order processing group (order processing): 20 CPU shares, 15 memory shares
- Inventory group (inventory): 10 CPU shares, 15 memory shares

- Development tools group (design tool, debugger, compilers): 40 CPU shares, 55 memory shares

Suppose the business application group (order processing, inventory) runs a critical database that requires on-demand, dedicated CPU cycles and memory. Create a PSET PRM group and assign the appropriate number of cores to it. Also, isolate the group's memory resources. The new application priority would be:

- Mail group (mail): 10 CPU shares, 5 memory shares
- User default group, word processing, and miscellaneous: 20 CPU shares, 10 memory shares
- Business application group (order processing, inventory): Core 1 and 2; 50 isolated memory shares
- Development tools group (design tool, debugger, compilers): 40 CPU shares, 55 memory shares

NOTE Because the business application group is a PSET PRM group using two of the system's cores, the FSS PRM groups get their CPU resource percentages calculated based on a reduced number of cores.

Identifying resource use

After identifying the model you want to use to configure PRM, collect data to understand the resources used in relation to that model. This includes CPU, memory, and disk bandwidth resource needs for all the PRM groups you plan to configure. You also need to know if your resource use pattern varies over time, for example, reflecting business needs or cycles. For instance, do the needs of a particular application change with your business cycle, such as activities at the end of a month, or do they vary during a single day, from morning to afternoon to night operations?

Quick analysis

If you need to implement PRM immediately to provide adequate resources to critical applications you could:

1. Identify CPU, memory, and disk bandwidth resource needs for each application. For information on how to collect this data, see “Using `prmanalyze` to quickly identify resource use” on page 81.
2. Create a PRM configuration file with a group for each high-priority application.
3. Assign all users to the user default group `OTHERS` (PRMID 1) as their initial group. (Use `prmloadconf -f` to make these assignments automatically.)

For example, suppose you have three departments that use the system. However, the order processing application used by the sales department is the most critical. The order processing application uses up to 40% of the CPU resources, 30% of memory resources, and 20% of disk bandwidth resources; the remainder of the resources are distributed among the other applications.

A resulting configuration might be:

- User default group: 60 CPU shares, 70 memory shares, 80 disk bandwidth shares
- Order processing group: 40 CPU shares, 30 memory shares, 20 disk bandwidth shares

In this configuration, the order processing group is used only for the order processing application.

The user default group is configured as the initial group for users. Any applications other than order processing are placed in the user default group and do not affect the order processing application.

Suppose this is a 10-core system. Another configuration might use a PSET PRM group:

- User default group: 60 CPU shares, 70 memory shares, 80 disk bandwidth shares
- Order processing group: Core 1, 2, 3, 4; 30 memory shares

In this configuration, the order processing group still has 40% of the total CPU resources, but four specific cores are dedicated to it. The memory shares remain the same. Assuming this is not a memory-intensive application, you do not need to isolate the memory shares.

Detailed analysis

The following steps outline a more detailed inspection of CPU, memory, and disk bandwidth resource use. This process is helpful to identify potential areas of conflict and ensure a workable PRM configuration. The `prmanalyze` utility can be very useful for detailed investigation into resource use. For information, see "Using `prmanalyze` to analyze your configuration" on page 162.

Step 1. Collect resource data

To refine your configuration, collect the following data based on your configuration model (either budget model or application priority model):

- The point in time (for example, time of day or time of month) that each potential PRM group starts consuming CPU, memory, and disk bandwidth resources.
- The length of time that each group consumes these resources.
- The amount of total resources consumed over time.
- Groups that have competing resource needs, that is, which users are actually trying to use the same resource at the same time.
- The amount of resources that are being used by each group.
- The length of time that a potential conflict exists.
- If there is a high degree of probability that the conflict will occur when the CPU, memory, or disk bandwidth resources are fully utilized (100% load).
- If there is a cyclic pattern to conflicting groups contributing to 100% resource load.
- Each group's proportion of CPU, memory, or disk bandwidth resources at 100% load.
- If consuming groups are getting enough resource during times of 100% load.

- If response times are appropriate for representatives of each conflicting group.

Step 2. Set up a preliminary configuration

With the preliminary data you have gathered, set up some PRM groups and assign them CPU, memory, and disk bandwidth resources, users, and applications, then observe system usage to determine:

- The PRM groups you need to match your configuration model.
- The initial and alternate PRM groups users need access to.
- The PRM groups that applications should be placed in to achieve a desired level of performance.

Step 3. Determine the resource allocations

To decide on the final resource allocation for your PRM groups:

1. Determine the allocations necessary for each group to get an appropriate level of performance.
2. Separate out the highest level user groups.
3. Determine which user groups could demand lots of CPU, memory, and disk bandwidth resources—if not limited.
4. Extrapolate from current data to identify user groups that will have increased resource needs in the future.
5. Determine the maximum CPU, memory, and disk bandwidth resources that each group should get at peak load.

Step 4. Make adjustments

After a trial period using the initial configuration, make adjustments to the configuration based on the following:

1. Collect data again.
2. Does the data reflect what you want and expect?
3. Are there any new conflicts?
4. Are there any new user or business demands?
5. Are there specific times when you might benefit from changing your configurations regularly?

Using `prmanalyze` to quickly identify resource use

The `prmanalyze` utility scans accounting files for information on the desired resource type (disk, memory, or CPU) and orders the accounting records by the requested sort key (user, UNIX group, command name, or PRMID).

This section focuses on the `prmanalyze` functionality that is relevant to quickly identifying resource use. Command options are used, but not described, in this section. For information on the command, see the section “`prmanalyze`” on page 203.

NOTE The following examples are for illustrative purposes only. They are not from an actual machine.

Step 1. Collect UNIX accounting data in a file (/var/adm/pacct by default) using `accton` *`filename`* if you do not already have any accounting files. Ideally, collect the accounting data over a period of one to seven days before using `prmanalyze`.

Step 2. Use `prmanalyze` to create a summary CPU report, sorted by command and piped to a reverse sort on the “`% total`” column:

```
# prmanalyze -s command -r cpu -p -t summary -1 filename | sort -r +5

summary CPU report by command name : 57203 records processed
unique id   processes    ave secs   peak secs    total secs  % total
mrkt_rsch         777    47198.00 13008184.00    2468339.00     34.03
financials        235   106583.00 24826696.00    1407889.00     19.41
web_browser      1359    12565.00   364533.00    1174329.00     16.19
sales_fcst        679    91231.00   788441.00     009676.00     13.92
f90com32          843     7573.00   104998.00     303193.00      4.18
vi               1743     1511.00    19840.00     125484.00      1.73
emacs              12   199219.00   639010.00     113879.00      1.57
```

The biggest CPU consumer is `mrkt_rsch`, a market research program. Because this program helps determine priorities in product development, it should be placed in a PRM group of its own. The second biggest consumer is `financials`. This is another critical program. It must run to completion each day. It also gets its own PRM group. The next program, web_broswer, also consumes a large amount of the CPU resources; however, it is not a critical application and should not be allowed to consume 16% of the CPU resource during peak periods. It needs to be placed in its own PRM group to restrict its resource use. The forecasting application sales_fcst deserves its own PRM group to ensure it gets enough CPU resources. The last three applications are not consuming significant amounts of CPU resources and do not require their own PRM groups.

Creating PRM groups for the applications mentioned above, then assigning appropriate CPU shares, the new PRM configuration is represented by Table 3-2.

Table 3-2 Initial configuration based on `prmanalyze`'s CPU report

Application	PRM group	CPU shares
mrkt_rsch	Research	35
financials	Finance	20
web_browser	Web	5
sales_fcst	Sales	15
All other applications	OTHERS	25

Step 3. Generate group/CPU records and application records to implement the configuration decided upon in Step 2.

Step 4. Use prmanalyze to create a summary CPU report, sorted by user and piped to a reverse sort on the "% total" column to determine if there are any critical users on the system that may require their own PRM groups:

```
# prmanalyze -s uid -r cpu -x root -p -t summary -1 filename | sort -r +5
```

The -x root combination prevents prmanalyze from showing data for root processes, which typically are placed in the PRM_SYS group (PRMID 0).

The output is omitted for brevity. However, assume the output shows that most of the sales forecast data is entered by one or two users, consuming approximately 3% of the CPU resources. For these users, create user records with sales_fcst as the initial PRM group. Then increase the CPU shares for sales_fcst from 15 to 18.

Instead of adding a user record for each of these users, you could create only one user record. This record would be for a new netgroup you define, say `finance_dept`. The netgroup would include these users. Using a netgroup also simplifies updates when the staff changes. For more information on using netgroups in user records, see "Specifying PRM users" on page 139.

Step 5. Use `prmanalyze` to create a summary memory report, sorted by command:

```
# prmanalyze -s command -r mem -p -t summary -1 filename

summary memory report by command name : 2231 records processed
unique id   processes       ave KB      peak KB     KB minutes  % total
mrkt_rsch         804       270.83   3132517.22     4273171.32    1.17
financials        759      4356.04    389279.46   107851933.76   29.53
f90com32          843     11921.09     16621.58     5003627.94    1.37
web_browser        98      8832.73   1076302.48     4930582.36    1.35
emacs              12         7.13      5009.34     3980988.79    1.09
vi               1743         7.00      7123.54     3688806.00    1.01
sales_fcst        779       349.81      1933.62    62490565.66   17.11
```

Based on this report, we can assign memory shares of 30 and 2 to the `Finance` and `Web` PRM groups respectively. The peak usage is also worth noticing. The `web_browser` application has a peak of approximately one Gbyte. This should be capped at 25% to prevent it from consuming too much memory. Also, the research program peaks at three Gbytes, causing poor response time for everyone. With a total of 4 Gbytes on the system, its group needs to be limited. The `Research` PRM group is consequently capped at 50%. Table 3-3 shows the configuration updated for memory management.

Table 3-3 Initial configuration based on prmanalyze's memory report

Application	PRM group	CPU shares	Memory shares	Memory cap
mrkt_rsch	Research	35	10	50%
financials	Finance	20	30	
web_browser	Web	5	2	25%
sales_fcst	Sales	18	20	
	OTHERS	22	38	

Step 6. Generate memory records to implement the configuration decided upon in Step 5.

Step 7. Use `prmanalyze` to create a summary disk bandwidth report, sorted by command and piped to a reverse sort on the “`% total`” column:

```
# prmanalyze -s command -r disk -p -t summary -1 filename | sort -r +5
```

The disk bandwidth summary report is omitted for brevity. However, the analysis explained in Step 2 and Step 5 can be applied for assigning disk bandwidth shares as well.

Use the data you have collected to configure PRM, as explained in Chapter 7.

4 Setting up PRM

This chapter explains how to set up PRM. It covers the following topics:

- Installing PRM
- Setting up your disks
- Setting PRM to start automatically at reboot

Installing PRM

PRM is installed using the Software Distribution (SD) utilities. Installation of PRM typically requires a kernel build and a reboot of the system. For more specific information, see the release notes, which are available in the /opt/prm/newconfig/RelNotes/ directory. See the release notes on http://docs.hp.com for the most up-to-date information.

During installation, a minimal /etc/prmconf file is created. After installation, PRM is unconfigured and disabled; the standard HP-UX resource management still controls the system.

PRM is installed at /opt/prm/.

Setting up your disks

To use PRM's disk bandwidth management, the disks to be controlled by PRM must be mounted and under the control of HP's Logical Volume Manager (LVM) or VERITAS Volume Manager™ (VxVM®).

If you would like to use disk bandwidth management with LVM, install patch PHKL_28150.

If you would like to use disk bandwidth management with VxVM, you will need to install a patch if you are using HP-UX 11i v1 (B.11.11). (For information on this patch, visit http://www.hp.com/go/prm.) On HP-UX 11i v2 (B.11.23) and later, no patches are needed.

LVM divides the disk in much the same way as the hard partitions implemented under earlier versions of HP-UX. However, logical volumes are much easier to reconfigure than partitions, and they can span two or more disks. These two attributes make LVM a much more powerful and flexible tool than hard partitions.

LVM is the most common disk-management method for current versions of HP-UX on all platforms.

LVM uses the concept of a volume group, which is a collection of one or more disks. A volume group can be divided into several partitions, which are called logical volumes.

NOTE When setting up LVM, do not create swap partitions in any volume group that is under PRM control.

For information on using LVM, see *HP-UX System Administrator's Guide* (HP-UX 11i v3) or *Managing Systems and Workgroups* (HP-UX 11i v1 or HP-UX 11i v2). This book is available on the web at http://docs.hp.com.

Setting PRM to start automatically at reboot

After rebooting your system, PRM is unconfigured and disabled if you have not previously configured the PRM startup script.

To preserve your configuration across reboots, modify the variables in the PRM startup script /etc/rc.config.d/prm to automatically configure PRM on reboot. This startup script configures PRM using the file you specify in /etc/rc.config.d/prm. If you do not specify a file, PRM uses an internal copy of the previous configuration file (either /var/tmp/PRM.prmconf or /var/tmp/PRM.prmconf.old if PRM.prmconf is not present).

For information, see the file /etc/rc.config.d/prm or "Protecting the PRM configuration from reboots" on page 194.

5 Using PRM with HP System Management Homepage (SMH)

HP System Management Homepage (SMH) enables you to perform various system administration tasks on a system through a single web interface. You can also configure and monitor PRM through SMH.

Quick start to using PRM's SMH interface

The following steps outline how to use PRM's SMH interface. For more information on configuring PRM using the SMH interface, see the PRM online help.

Step 1. Determine which configuration model you are going to use.

For information on planning your configuration, see "PRM configuration planning" on page 71.

Step 2. Log in to HP System Management Homepage by pointing your web browser to:

http://*SMH_host*:2301

where *SMH_host* has SMH and PRM C.03.02 or later installed.

By using port 2301, if SMH is not currently running on *SMH_host*, it is started.

For more information, see the hpsmh(1M) manpage. Additional SMH documentation is available on http://docs.hp.com by selecting the Network and Systems Management link.

Step 3. Navigate to the PRM interface by following the links:

Tools -> Resource Management -> Manage PRM Groups

NOTE If the above links are not present, run the following command:

```
# /opt/prm/bin/prmsmhconfig -c
```

and log in to SMH again as indicated in Step 2.

Step 4. Create your configuration file.

For help in determining the resource allocations in your initial configuration, see "Using `prmanalyze` to quickly identify resource use" on page 81.

For configuration tips, see "Configuration tips and requirements" on page 102.

To create configuration files, once you navigate to the PRM interface, select the Configure tab.

For information on how to use SMH to create the configuration, see the online help.

Step 5. Load the configuration.

There are two types of loads:

- Move processes to assigned groups

  To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups

- Keep processes in current groups

  To keep the existing assignments of users, processes, and groups

On the Configure tab, select the desired type of load and select the Load button. Any resource managers needed based on the types of records in the configuration will be automatically started.

Step 6. Enable PRM.

On the Configure tab, in the Resource Manager Configuration area, change options as desired for the loaded configuration file and then select the Apply button.

Step 7. Confirm that the processes are running in the appropriate PRM groups:

```
# ps -efP
```

6 Using PRM with HP Systems Insight Manager (SIM)

This chapter discusses how you can use PRM with HP Systems Insight Manager (SIM), which provides a single point of administration for multiple HP-UX systems. The PRM integration with HP SIM allows system administrators at a SIM Central Management Server (CMS) to perform the following PRM tasks on the nodes in the SIM cluster that have PRM installed:

- Monitor PRM Groups
- Configure PRM Groups
- Display Resource Usage
- List Resource Availability

What PRM tasks are available through SIM?

The following sections describe the PRM tasks available through SIM.

Monitor PRM Groups

Enables you to monitor PRM groups on the specified target nodes.

Configure PRM Groups

Enables you to create PRM groups on the specified target nodes.

Display Resource Usage

Executes the `prmlist` command on the specified target nodes. Command output as well as error messages produced by `prmlist` are displayed in the SIM GUI.

For this task to display meaningful results, a valid configuration file must be loaded on the target systems.

List Resource Availability

Executes the `prmavail -p` command on the specified target nodes. Command output as well as error messages produced by `prmavail -p` are displayed on the SIM GUI.

This tool does not require a valid configuration on the target systems in order to produce meaningful results.

Configuring user authorizations

You must be authorized in HP SIM to run the PRM tools. To configure user authorizations, you must be logged into HP SIM as a user with Full Configuration Rights. Refer to mxuser(1M) for information about viewing and setting configuration rights. Choose Options**->**Security**->**Users and Authorizations from the HP SIM menu bar. Use the tabs to view and change the toolbox authorizations for each user. For detailed information about creating and updating authorizations, refer to the HP SIM online help.

The following list defines the authorization provided by each of the toolboxes associated with PRM:

PRM All Tools — Authorize this toolbox on managed systems to allow users to monitor and configure the PRM groups on those systems. Authorize on the CMS only if the CMS will also be a managed system.

PRM Monitor — Authorize this toolbox on managed systems to allow users to monitor the PRM groups. Authorize on the CMS only if the CMS will also be a managed system.

The following sections present examples showing how to configure authorizations based on the user's role.

Role: PRM administrator

With the authorizations from the table below, you can examine the configuration of all managed systems through Virtualization Manager. You can monitor and configure the amount of CPU, memory, and disk bandwidth resources used by PRM groups on the CMS and managed systems.

Table 6-1 HP SIM toolboxes needed for PRM administrator role

Toolbox	Systems Authorized
VSE Monitor	CMS and All Managed Systems
PRM All Tools	CMS and All Managed Systems

Role: PRM operator

With the authorizations from the table below, you can examine the configuration of all managed systems through Virtualization Manager. You can monitor the amount of CPU, memory, and disk bandwidth resources used by PRM groups on the CMS and managed systems. You cannot make any configuration changes to the PRM groups.

Table 6-2 HP SIM toolboxes needed for PRM operator role

Toolbox	Systems Authorized
VSE Monitor	CMS and All Managed Systems
PRM Monitor	CMS and All Managed Systems

Quick start to using PRM's SIM interface

The following steps outline how to use PRM's SIM interface. For more information on configuring PRM using the SIM interface, see the PRM online help.

Step 1. Determine which configuration model you are going to use.

For information on planning your configuration, see "PRM configuration planning" on page 71.

Step 2. Log in to HP Systems Insight Manager by pointing your web browser to:

http://*`SIM_host`*:280

where *`SIM_host`* has SIM and the bundle PRMSIMTools C.03.03.01 or later installed.

SIM documentation is available on http://docs.hp.com by selecting the Network and Systems Management link.

Step 3. Navigate to the PRM interface by following the links:

Optimize **->** Process Resource Manager **->** Configure PRM Groups

NOTE If the above links are not present, run the command `/opt/prm/bin/prminitconfig -a` (or preferably `/opt/vse/bin/vseinitconfig -a` if HP Virtual Server Environment Management Software A.03.00.00 or later is installed) and log in to SIM again as indicated in Step 2. (Be aware that running `vseinitconfig -a` will restart SIM.)

Step 4. Create your configuration file.

For help in determining the resource allocations in your initial configuration, see "Using `prmanalyze` to quickly identify resource use" on page 81.

For configuration tips, see "Configuration tips and requirements" on page 102.

To create configuration files, once you navigate to the PRM interface, select the Configure tab.

For information on how to use SIM to create the configuration, see the online help.

Step 5. Load the configuration.

There are two types of loads:

- Move processes to assigned groups

  To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups

- Keep processes in current groups

  To keep the existing assignments of users, processes, and groups

On the Configure tab, select the desired type of load and select the Load button. Any resource managers needed based on the types of records in the configuration will be automatically started.

Step 6. Enable PRM.

On the Configure tab, in the Resource Manager Configuration area, change options as desired for the loaded configuration file and then select the Apply button.

Step 7. Confirm that the processes are running in the appropriate PRM groups:

```
# ps -efP
```

7 Configuring and enabling PRM on the command line

This chapter explains the tasks necessary to configure and enable PRM. Topics covered include:

- Quick start to using PRM's command-line interface
- Configuring PRM
  - — The PRM configuration file
  - — Configuration tips and requirements
  - — Specifying PRM groups/controlling CPU resource use
  - — Controlling memory use
  - — Controlling disk bandwidth
  - — Controlling applications
  - — Specifying PRM users
  - — Assigning secure compartments to PRM groups
  - — Assigning Unix groups to PRM groups
  - — Checking the configuration file
  - — Loading the PRM configuration
- Enabling resource managers
- Updating the configuration

Various PRM commands are mentioned in this chapter. See "Command reference" on page 201 for information on these commands.

Quick start to using PRM's command-line interface

The following steps outline how to use PRM's command-line interface. Detailed information on these topics is available in the remainder of the chapter.

Step 1. Determine which configuration model you are going to use.

For information on planning your configuration, see "PRM configuration planning" on page 71.

Step 2. Create your configuration file. Use the `prmloadconf` command to create the default /etc/prmconf configuration file (if it is not present).

For help in determining the resource allocations in your initial configuration, see "Using `prmanalyze` to quickly identify resource use" on page 81.

Step 3. Customize the configuration file manually in a text editor.

Step 4. Check the syntax of the configuration file manually with `-s` or `-c`, as shown below. (The `-c` checks are a subset of the `-s` checks.)

`#` **`prmconfig {-s | -c} [-f`** *`configfile`***`]`**

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf.

Step 5. Load the configuration using one of the commands below:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`#` **`prmconfig -i [-f`** *`configfile`***`]`**

To keep the existing assignments of users, processes, and groups, use the command:

`#` **`prmconfig -k [-f`** *`configfile`***`]`**

Step 6. Enable PRM:

`#` **`prmconfig -e`**

Step 7. Confirm that the processes are running in the appropriate PRM groups:

```
# ps -efP
```

Configuring PRM

Configuring PRM is independent of enabling PRM. You can configure PRM without enabling it. In such a state, PRM stamps processes with PRM group identifiers so that their resource usage can be controlled when you enable the PRM CPU, memory, disk, or application manager. For information on how to enable PRM, see “Enabling resource managers” on page 156.

The following sections explain PRM’s configuration file and how to configure PRM.

The PRM configuration file

The PRM configuration file defines PRM groups and their resource shares. It also specifies which PRM groups each user can access and which applications are assigned to PRM groups. The default configuration file is /etc/prmconf; however, you can create and use alternate configuration files, which are usually kept in the directory /etc/opt/prm/conf/, with the owner set to hpsmh.

The PRM configuration file contains the following record types:

- Group/CPU
- Memory
- Disk bandwidth
- Application
- User
- Compartment
- Unix group

Specify PRM groups and CPU allocations in group/CPU records. The configuration file must contain a group/CPU record for each PRM group you want to create on your system. The file must also contain a group/CPU record for any PRM group listed in a user or application record. Optionally, define memory records to assign memory allocations for the groups. Also optionally, use disk records to assign disk bandwidth shares for the groups (FSS PRM groups only). Use compartment records, also optional, to map secure compartments to PRM groups. (Create secure compartment configurations using the HP-UX feature Security Containment—or a PRM utility such as `srpgen` or `prm2scomp`.) Use the optional Unix group records to map Unix groups on the system to PRM groups.

Each PRM group is denoted by an identifier called a PRM group ID, or PRMID. The PRMID for an FSS PRM group must be an integer between 0 and 63 (inclusive) or between 0 and 255 (inclusive) starting with HP-UX v2 Update 2. PRMID 0 is reserved for the `PRM_SYS` group, and PRMID 1 is reserved for the `OTHERS` group. PSET PRM group IDs are assigned by PRM. When using the PRM interface in HP System Management Homepage or in HP Systems Insight Manager to create groups, all PRMIDs are automatically assigned.

You do not need to specify PRM user records for all users on your system. Users without PRM user records are automatically assigned to the user default group, `OTHERS` (PRMID 1).

Create application records for those applications requiring a certain level of resources. However, you do not need to assign every application to a PRM group. An application without a PRM application record runs in the initial PRM group of the invoking user.

For detailed syntax information on configuration files, see the prmconf(4) manpage.

In addition to syntax requirements, it is important to keep the following configuration file requirements in mind:

- PRM automatically assigns system processes to the group `PRM_SYS` (PRMID 0) and calculates this group's resource needs. You do not need to specify the `PRM_SYS` group in the PRM configuration file.

NOTE If you are configuring PRM to manage memory resources, the PRM configuration file must not contain a `PRM_SYS` group. If the group is already present, delete it.

- The user default group, `OTHERS` (PRMID 1), is required in the PRM configuration file.
- Nonroot users cannot have access to the system group `PRM_SYS` (PRMID 0).

The default PRM configuration file, /etc/prmconf, is created automatically when you install PRM. Execute the `prmloadconf` utility to create the /etc/prmconf file if it is not present. To create the same configuration file with a name other than /etc/prmconf, use `prmloadconf -f` *`configfile`*, specifying your preferred name in place of *`configfile`*. Keep alternate configuration files in the directory /etc/opt/prm/conf/, with the owner set to hpsmh.

Use the configuration file created by `prmloadconf` as a template to establish your specific configuration. Customize this file based on your configuration planning. Configuration planning is discussed in "PRM configuration planning" on page 71.

The generic configuration file contains:

- A PRM group/CPU record for the user default group, `OTHERS` (PRMID 1) and 100 CPU shares.
- A PRM user record for each user specified in the /etc/passwd file. Root users are assigned to the group `PRM_SYS`. For each nonroot user, instead of placing the user in a PRM group, a record is created using the placeholder `(NONE)`. The typical PRM placement rules then apply to the processes owned by the given user. (For information on the placement rules, see "Precedence of PRM group assignments" on page 65.)
- On HP-UX 11i v2 (B.11.23) and later, a PRM compartment record for each active secure compartment. Instead of mapping the compartment to a PRM group, each record uses the placeholder `(NONE)`. (You create secure compartments using the HP-UX feature Security Containment. You can also create secure compartment configurations using a PRM utility such as `srpgen` or `prm2scomp`.)
- A PRM Unix group record for each Unix group defined on the system. Instead of mapping the Unix group to a PRM group, each record uses the placeholder `(NONE)`.

If you add or modify users in /etc/passwd after installing PRM, execute `prmloadconf` to add new PRM user records to your configuration file for the new or modified /etc/passwd entries. These new PRM user records are created with the placeholder `(NONE)` instead of a PRM group. Compartment records and Unix group records are also created. `prmloadconf` retains any customization you have made to an existing configuration file.

Configuration tips and requirements

When altering a PRM configuration, keep in mind:

- Assigning memory shares to groups is optional. However, if do you assign memory shares, you must assign them to all PRM groups. You cannot assign memory shares in a configuration with `PRM_SYS` explicitly defined.
- Disk bandwidth is assigned per logical volume group (LVM) or per disk group (VxVM). You can assign an FSS PRM group different disk bandwidth shares for each logical volume group/disk group. Assigning disk bandwidth shares to groups is optional. However, if

you assign shares to a volume group/disk group for one FSS PRM group, you must assign shares for that volume group/disk group to all FSS PRM groups.

- The minimum CPU and memory shares are one. (Assigning one share is rarely a good idea for any resource.) The minimum number of disk bandwidth shares you can assign is zero.
- FSS PRM group PRMID numbers must be in a range from 0 to 63 or from 0 to 255 starting with HP-UX 11i v2 Update 2. (PRMIDs for PSET PRM groups are assigned by PRM). PRMID 0 is reserved for the system group, `PRM_SYS`. PRMID 1 is reserved for the user default group, `OTHERS`. PRMID numbers must be uniquely assigned.
- PRM internally creates the group `PRM_SYS` (PRMID 0) and assigns system processes to it. Therefore, you do not need to specify a `PRM_SYS` group in the PRM configuration file. If you are upgrading an existing configuration file that contains a `PRM_SYS` group, delete this group.
- The PRMID 1 (default name `OTHERS`) group must appear in the PRM configuration file. However, you do not need to assign any users to it.
- Users not listed in the configuration file will use the user default group, PRMID 1 (`OTHERS`), as their initial group. If your implementation expects the user default group to carry a significant load of users, the user default group should have an appropriate number of shares to meet their needs.
- Root users can occupy any group.
- The configuration file must contain a group/CPU record for each PRM group you want to create on your system and for all PRM groups listed in PRM user and application records.
- Do not set memory/CPU and disk shares at opposite ends of the spectrum and expect to see the desired percentages achieved. If a process cannot run, it cannot request I/O. Typically, disk shares that represent over 90% or under 10% of the disk resource will tend to be less accurate due to such scheduling-induced or demand-induced fluctuations.
- Several NFS system processes run on behalf of network-generated requests. If these processes consume substantial CPU, memory, and disk bandwidth resources from the system group (`PRM_SYS`), consider using the `prmmove` command to move these processes to their own PRM groups to free up the system group.

- The internet services daemon, `inetd`, should be placed in a group other than the system group if the services or their children are using too much CPU, memory, or disk bandwidth resources.
- The user processes of some alternate login methods are not placed in their appropriate initial PRM groups unless PRM's application manager is running. See "Special case of interest: Client/server connections" on page 198 for more information.
- Pattern matching of alternate names in application records should not generate redundant or conflicting names.

Specifying PRM groups/controlling CPU resource use

You can change PRM groups and their CPU resource use as discussed in the following sections:

- "Adding/modifying PRM groups and CPU allocations" on page 110
- "Capping CPU resource use" on page 111
- "Removing groups/CPU allocations" on page 112

Reserved PRM groups

When defining your PRM groups, keep in mind that there are two groups reserved by PRM. The reserved PRM group IDs (PRMIDs) are 0 and 1. The group designated by PRMID 0 is the `PRM_SYS` group, or system group. This group is created automatically and serves as the PRM group for system processes. When a PRM configuration is loaded, existing root logins stay in the `PRM_SYS` group—unless they have a user record assigning them to other groups. Similarly, new root logins are placed in `PRM_SYS`, unless a user record indicates otherwise.

By default, PRM gives `PRM_SYS` 100 CPU shares. If you assign 100 shares to the PRM groups you create, `PRM_SYS` gets 50% (100/200) of the CPU resource. The `PRM_SYS` group must get at least 20% of the CPU resource. Thus, if you assign more than 400 shares to your groups, the total shares assigned is greater than 500, and the `PRM_SYS` group's 100 shares do not represent at least 20%. In this case, PRM scales the shares for your groups proportionately so they are less than or equal to 400 shares.

You can explicitly add the PRM_SYS (PRMID 0) group to a configuration file. However, if you explicitly add the PRM_SYS group to a configuration file, it gets the CPU shares you assign it, which must equate to at least 20%.

You can also assign disk bandwidth shares to an explicitly defined PRM_SYS group.

You cannot, however, assign memory shares to an explicitly defined PRM_SYS group. Consequently, you also cannot specify memory shares for any other group in a configuration where the PRM_SYS group is explicitly defined due to the required one-to-one correspondence between group/CPU records and memory records. The PRM_SYS group is allowed to use as much memory as it needs.

If you do not explicitly add PRM_SYS to your configuration, it is created automatically and appears in the output of `prmmonitor -s` and `ps -P` in parentheses: `(PRM_SYS)`.

By default, all processes run by root (user ID of 0) are placed in the PRM_SYS group—unless the processes have application records or are moved manually.

Do not consider the PRM_SYS group or its default shares when determining resource shares. The shares you assign in a PRM configuration file divide what remains after PRM_SYS is granted its resources. Typically, PRM_SYS resource use is minimal.

When CPU capping is enabled, the PRM scheduler does not schedule processes for the next PRM group until the current group's CPU time has elapsed. However, the PRM_SYS group is not required to use its entire CPU time slice before the scheduler allocates time to the next PRM group. In effect, this unused time is distributed to the other PRM groups according to their relative number of their shares.

The PRMID 1 group, which is named OTHERS, is the default for users who do not have assigned initial groups. You must explicitly define this group in your configuration file, although you do not have to use the default name.

Group/CPU record syntax

This section explains the syntax of group/CPU records.

Group/CPU records specify PRM groups and their CPU allocations in your configuration file.

Group/CPU records have the following syntax for FSS PRM groups, hierarchical groups, and PSET PRM groups, respectively:

```
GROUP:PRMID:SHARES:[MAX]:
```

```
GROUP:HIER:SHARES::
```

```
GROUP:PSET:::[CORES]:[CORE_LIST][:PSET_ATTR]
```

where

`GROUP` Specifies the PRM group name. The PRM group can be the traditional PRM group (FSS PRM group) or a PSET PRM group.

The group name must contain at least one alphabetic character and contain no more than 49 characters. Use names that are less than eight characters long for optimal display when using the `ps` command.

In a hierarchy, an FSS PRM group's full name is formed by combining its short name with all of its ancestors' group names, using a slash ("/"):

```
Development/Compilers/Fortran
```

You cannot use hierarchical grouping for PSET PRM groups.

Because PRM group names are limited to 49 characters, a hierarchy can have no more than 25 components. Using single-character group names with each (but the last) followed by a slash character ("/"), the hierarchy can go to a maximum depth of 25 levels.

`PRMID` Specifies the FSS PRM group ID (PRMID). This number must be uniquely assigned and can range from 0 to 63 or from 0 to 255 starting with HP-UX 11i v2 Update 2. (PRMID 0 is reserved. It is also known as the system group `PRM_SYS` and is automatically created by PRM. PRMID 1 is also reserved. It is known as the `OTHERS` group and is the default for users without user records. You must create this group explicitly.) PSET PRM group PRMIDs are assigned by PRM and are not specified in the group record.

`HIER` Indicates the PRM group is a parent group in a hierarchy and that it has no PRMID. The reserved group names `OTHERS` and `PRM_SYS` cannot be parent groups. Also, you cannot use PRMID 0 for a child group. You can, however, use PRMID 1 for a child group.

For information on hierarchical groups, see “Hierarchical PRM groups” on page 38.

`PSET` Indicates the PRM group is a PSET PRM group. In this case, `SHARES` is not used. Instead, use the `CORES` and `CORE_LIST` fields to specify the cores assigned to the PSET.

NOTE

When you have PRM groups based on PSETs enabled:

- Do not modify the PSETs manually using the `psrset` command
- Do not adjust CPU counts in virtual partitions using the `vparmodify` command
- Do not adjust Instant Capacity (iCAP), Temporary Instant Capacity (TiCAP), or Pay Per Use resources using the `icapmodify` or `ppuconfig` commands
- Do not perform online cell operations, using `parolrad` or any other interface, while PRM is managing the system (For more information, see the WARNINGS section in the prmconfig(1) manpage.)

`SHARES` Specifies the FSS PRM group’s CPU shares. Shares are integer values ranging from one to `MAXINT`.

An FSS PRM group’s resource percentage is determined by its number of shares relative to the sum of the shares for its set of sibling groups. For more information on shares, see “Resource allocation” on page 34. If the total number of shares is 100, each group’s shares represent the percent of CPU resources that the group receives.

When CPUCAPON mode is enabled, the percentages computed from the SHARES values of the FSS PRM groups are also used as caps. For information on this mode, see the section "Capping CPU resource use" on page 111. You can enable per-group CPU capping using the MAX field discussed next.

MAX

(Available for HP-UX 11i v3 and later.) MAX is an upper bound for CPU consumption for the FSS PRM group. It is an integer percent value, ranging from the percentage determined by the group's number of CPU shares to 100.

The sum of the max values in a configuration does not have to be 100%.

The percentage computed from the SHARES value, instead of the MAX value, is used as the group's upper bound when CPUCAPON mode is enabled. This mode enables capping for all FSS PRM groups in the configuration. For more information on this mode, see the prmconfig(1) manpage.

CORES

Is the number of cores assigned to the PSET PRM group. (A core is the actual data-processing engine within a processor. A single processor might have multiple cores. A core might support multiple execution threads, as explained in the section "Hyper-Threading" on page 49.) The range for this field is from 0 to MAX_CORE-1. The number of cores must agree with the number of cores in CORE_LIST, if CORE_LIST is specified. If it is not specified, PRM chooses which cores to use. However, PRM does not guarantee to choose an optimal set of cores.

CORE_LIST

Is the comma-delimited list of core IDs for the cores to be assigned to the PSET PRM group. You cannot specify core ID 0 in CORE_LIST. The number of cores specified in the CORES field must match the number of cores listed in CORE_LIST.

PSET_ATTR — Passes attributes for the specified PSET to HP-UX. (For a complete attribute list, see the -t option in the psrset(1M) manpage.) The only attribute currently available is the logical CPU (Hyper-Threading) feature, available starting with HP-UX 11i v3 (B.11.31). Set this attribute as follows:

LCPU=ON — Explicitly enables Hyper-Threading

LCPU=OFF — Explicitly disables Hyper-Threading

If PSET_ATTR is not specified, a nondefault PSET inherits the Hyper-Threading state the system had before PRM was enabled. (The state from before PRM was enabled is used because PRM may change the Hyper-Threading setting for PSET 0, where FSS PRM groups are created, to optimize workload performance.)

Consider the following example group/CPU records:

```
# PRM group records

OTHERS:1:20::
databases:HIER:30::
databases/inventory:2:10::
databases/order:3:20::
development:4:40::
mailserver:5:10::
management:PSET:::2:3,4
```

These group/CPU records define:

- A user default group (PRMID 1) with the name OTHERS. This group is granted 20 CPU shares.
- A databases hierarchical FSS PRM group to house the inventory and order databases.
- An inventory FSS PRM group (PRMID 2) in the databases hierarchy. This group is granted 10 CPU shares.
- An order processing FSS PRM group (PRMID 3) in the databases hierarchy. This group is granted 20 CPU shares.
- An FSS PRM group development (PRMID 4) with 40 CPU shares.

- An FSS PRM group `mailserver` (PRMID 5) with 10 CPU shares.
- A `management` PSET PRM group with two cores assigned. The specific cores assigned are Core 3 and Core 4.

Adding/modifying PRM groups and CPU allocations

To add or modify a group/CPU record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Add or modify a line specifying the group name, `PRMID`, `HIER` or `PSET` keyword, and CPU allocations. Use the syntax shown below:

```
GROUP:PRMID:SHARES:[MAX]:
GROUP:HIER:SHARES::
GROUP:PSET:::[CORES]:[CORE_LIST][:PSET_ATTR]
```

and explained in the section “Group/CPU record syntax” on page 105.

Step 3. Add or modify memory and disk bandwidth records as needed. For more information, see “Controlling memory use” on page 113 or “Controlling disk bandwidth” on page 123.

Step 4. Save the file and exit your editor.

Step 5. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners’ initial groups and moving applications to their assigned groups, use the command:

`# `**`prmconfig -i [-f`** *`configfile`*`] {-s | -c}`**

To keep the existing assignments of users, processes, and groups, use the command:

`# `**`prmconfig -k [-f`** *`configfile`*`] {-s | -c}`**

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 6. Enable PRM’s CPU manager if it is not already enabled:

```
# prmconfig -e CPU
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Capping CPU resource use

CPU capping allows you to limit the amount of CPU resources that FSS PRM groups use. PRM provides two types of CPU capping:

- On a per-group basis

  (Available for HP-UX 11i v3 and later.) For per-group capping, use the `MAX` field in the FSS PRM group record (discussed in the section “Group/CPU record syntax” on page 105) for only those groups you want to cap.

- For all FSS PRM groups in the configuration

  The `CPUCAPON` mode, enabled through the `prmconfig -M` option, is discussed below. In this mode, PRM treats the minimum allocation for each FSS PRM group as its maximum allocation.

The syntax for a FSS group/CPU record is:

```
GROUP:PRMID:SHARES:[MAX]:
```

When you cap CPU resource use via `CPUCAPON` mode, the percentages computed from the `SHARES` values of the FSS PRM groups are also used as caps. The mode is in effect for all user-configured FSS PRM groups on a system when enabled, regardless of system load. This mode, however, does not affect the `PRM_SYS` group. PSET PRM groups are capped on CPU resource use as a result of the number of cores assigned to the group.

Turn on CPU capping by entering the command:

```
# prmconfig -M CPUCAPON
```

Turn off CPU capping by entering the command:

```
# prmconfig -M CPUCAPOFF
```

Using `prmconfig -r` or `prmconfig -d CPU` also turns CPU capping off.

Removing groups/CPU allocations

To remove group/CPU allocations with a text editor:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the group/CPU record you wish to remove. If the group is a parent group, you will need to remove all the child groups first. Group/CPU records have one of the following forms:

```
GROUP:PRMID:SHARES:[MAX]:
GROUP:HIER:SHARES::
GROUP:PSET:::[CORES]:[CORE_LIST][:PSET_ATTR]
```

Step 3. Remove or modify application, memory, disk bandwidth, or user records that referenced the PRM group removed in Step 2.

Step 4. Save the file and exit the text editor.

Step 5. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`# prmconfig -i [-f configfile] {-s | -c}`

To keep the existing assignments of users, processes, and groups, use the command:

`# prmconfig -k [-f configfile] {-s | -c}`

Use the `-f` *configfile* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 6. Enable PRM's CPU manager if it is not already enabled:

`# prmconfig -e CPU`

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

`# prmconfig -e`

Controlling memory use

You can define private memory shares and caps for existing PRM groups as well as allocate shared memory as discussed in the following sections:

- "Adding/modifying private memory shares/caps" on page 118
- "Adding/modifying shared memory allocations" on page 119
- "Removing private memory shares" on page 120
- "Removing shared memory allocations" on page 121
- "Isolating private memory for a group" on page 122

Memory record syntax

This section explains the syntax of memory records. PRM can control allocation of both private and shared memory. The PRM configuration file has separate record types for allocating memory, based on whether the memory is private or shared. The syntax for each of these records is discussed below.

NOTE Do not perform online cell operations, using `parolrad` or any other interface, when PRM is managing memory. For more information, see the WARNINGS section in the prmconfig(1) manpage.

Private memory Private memory records define real memory shares and caps. They also allow you to isolate the memory of a group.

Memory records are optional. However, if you use PRM memory management, you must have one memory record that corresponds to each group/CPU record. A memory record corresponds to a group/CPU record when the PRMIDs or group names match.

NOTE Note that each memory record must be preceded by the `#!` characters. These lines are not treated as comments.

A white paper, titled *HP Process Resource Manager memory resource groups: Memory calculation*, on the web at http://h20338.www2.hp.com/hpux11i/downloads/5983-1676EN.pdf presents a case study of setting memory allocations for PRM groups.

Use the following syntax to specify a memory record:

```
#!PRM_MEM:{PRMID|GROUP}:SHARES:[MAX]:::[[IMPORT]:[EXPORT]:]
```

where

`#!PRM_MEM`	Indicates the start of a memory record.
`PRMID	GROUP`	Is a PRM group ID or group name that corresponds to an existing group. When specifying parents in a group hierarchy, use their names.
`SHARES`	Specifies the group's guaranteed proportion of available memory. Shares are integer values ranging from one to `MAXINT`.
`MAX`	(Optional) Specifies a cap (upper bound) for memory consumption for any non-`HIER` PRM group. This integer value represents a percentage and must be greater than or equal to the percentage determined by the group's number of memory shares. There is no requirement that the max values total 100%.
`IMPORT`, `EXPORT`	Allow a PRM group to borrow or lend memory resources. Leave both fields blank to allow unrestricted borrowing and lending. (Leaving the fields blank enables the proportional overachievement feature.) Assign both fields a value of 0 to isolate a memory-critical group to ensure it gets exactly the memory you give it. You cannot set `EXPORT` to 0 for the `OTHERS` group.

NOTE If you add memory records to the PRM configuration file, your configuration file must not contain a `PRM_SYS` (PRMID 0) group. If the group is already present, delete it.

Consider the following example memory records:

```
# PRM memory records

#!PRM_MEM:1:10:25:::
#!PRM_MEM:databases:30::::
#!PRM_MEM:databases/inventory:15::::
#!PRM_MEM:3:15::::
#!PRM_MEM:4:55::::
#!PRM_MEM:5:5:15:::
#!PRM_MEM:6:20::::0:0:
```

The example shows:

- A memory record for PRMID 1 (group `OTHERS`), which specifies 10 memory shares. The memory cap is 25%.
- The parent group `databases` starts a hierarchy and is granted 30 memory shares to be divided by its child groups.
- A memory record for the `databases/inventory` group. Rather than using its name, we could have used its PRMID, which is 2, as we see from the example in the section "Group/CPU record syntax" on page 105. This record specifies 15 memory shares. No memory cap is set.
- A memory record for PRMID 3. We could have used the group's name, `databases/order`, in place of the PRMID. This record specifies 15 memory shares. No memory cap is set.
- A memory record for PRMID 4, which grants 55 memory shares. No memory cap is set.
- A memory record for PRMID 5, which grants 5 memory shares. The memory cap is 15%.
- A memory record for PRMID 6, which grants 20 memory shares. The memory is isolated—the group cannot loan or borrow available memory.

Shared memory A shared memory record is a request that PRM try to keep a minimum number of megabytes of physical memory available for use as shared memory for the specified PRM group. (As pages in the shared memory segment are paged out, PRM will attempt to maintain the requested amount of physical memory for the PRM group. To maintain the current PRM group's physical memory, memory in other PRM groups may be paged out more aggressively. PRM does not provide any method for limiting the shared memory available to a PRM group.)

PRM groups without a shared memory record default to `PRM_SYS` for shared memory allocation.

NOTE Note that each shared memory record must be preceded by the `#!` characters. These lines are not treated as comments.

The shared memory control feature is supported on HP-UX 11i v2 Update 2 and later.

Use the following syntax to specify a shared memory record:

```
#!SHARED_MEM:{PRMID|GROUP}:MEGABYTES
```

where

`#!SHARED_MEM` Indicates the start of a shared memory record.

`PRMID | GROUP` Is a PRM group ID or group name for a group that already has a private memory record. This group ID or group name cannot correspond to a parent group in a PRM group hierarchy.

You can selectively specify shared memory records: Not every PRM group must have one.

`MEGABYTES` Is the size of the desired shared memory allocation for the PRM group in megabytes. This value serves as a request for a minimum allocation.

The size should reflect the needs of the application in the PRM group. Shared memory management is optimized for one shared memory segment, such as one Oracle SGA, per PRM group.

NOTE

If the PRM group uses a larger shared memory segment, it must borrow the difference. It attempts to borrow the difference from its private memory allocation first, then from other user-defined PRM groups, and then from the `PRM_SYS` group. You should avoid this borrowing, if possible, by determining how much shared memory a workload allocates and then setting `MEGABYTES` to 1.1 times that size.

The minimum `MEGABYTES` value corresponds to the page size. (Page sizes can be 4KB, 8KB, 16KB, or 64KB. You must have at least 256 pages, so the minimum `MEGABYTES` values are 1, 2, 4, or 16 depending on the system's page size.) The maximum value is limited by the available megabyte value reported by `prmavail` minus the `MEGABYTES` values for all shared memory records and the megabyte value corresponding to the sum of the `SHARES` amounts for all memory records.

Consider the following example memory records:

```
# PRM shared memory records

#!SHARED_MEM:2:10
#!SHARED_MEM:tools/compilers:10
```

The example shows:

- A memory record for PRMID 2, which specifies 10 megabytes of memory.
- A memory record for the `tools/compilers` group. This record specifies 10 megabytes for the group.

Adding/modifying private memory shares/caps

To add or modify a memory record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
#!PRM_MEM:{PRMID|GROUP}:SHARES:[MAX]:::[[IMPORT]:[EXPORT]:]
```

and explained in the section “Memory record syntax” on page 113:

a. Add or modify a line specifying a PRMID or group name for an existing group.

b. Specify an integer number of shares.

c. Optionally, assign a memory cap. This cap must be greater than or equal to the percentage represented by the number of shares specified in Substep b. (Memory caps do not have to sum to 100%.)

d. Optionally, isolate the memory by specifying an `IMPORT` and `EXPORT` value of 0.

NOTE You cannot set `EXPORT` to 0 for the `OTHERS` group.

Step 3. Ensure that there is a one-to-one correspondence between the memory records and group/CPU records.

Step 4. Save the file and exit your editor.

Step 5. Load the configuration using one of the commands below.

To initialize, moving user processes to the owners’ initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 6. Enable PRM's memory manager if it is not already enabled:

```
# prmconfig -e MEM
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Adding/modifying shared memory allocations

To add or modify a shared memory record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
#!SHARED_MEM:{PRMID|GROUP}:MEGABYTES
```

and explained in the section "Memory record syntax" on page 113:

a. Add or modify a line specifying a PRMID or group name for an existing group.

b. Specify the size of the shared memory allocation in integer megabytes.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the commands below.

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's memory manager if it is not already enabled:

```
# prmconfig -e MEM
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Removing private memory shares

To remove a memory record manually:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the memory record you wish to remove. Memory records have the following form:

```
#!PRM_MEM:{PRMID|GROUP}:SHARES:[MAX]:::[[IMPORT]:[EXPORT]:]
```

Step 3. (Optional) Adjust the memory shares of the remaining records to ensure their resource allocations are as desired.

Step 4. Ensure there is still a one-to-one correspondence between memory records and group/CPU records if there are any memory records still present in the configuration.

Step 5. Save the file and exit the text editor.

Step 6. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 7. Enable PRM's memory manager if it is not already enabled:

```
# prmconfig -e MEM
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Removing shared memory allocations

To remove a memory record manually:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the shared memory record you wish to remove. Shared memory records have the following form:

```
#!SHARED_MEM:{PRMID|GROUP}:MEGABYTES
```

Step 3. Save the file and exit the text editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's memory manager if it is not already enabled:

```
# prmconfig -e MEM
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Isolating private memory for a group

To isolate memory for a group, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
#!PRM_MEM:{PRMID|GROUP}:SHARES:[MAX]:::[[IMPORT]:[EXPORT]:]
```

and explained in the section “Memory record syntax” on page 113:

a. Find the memory record in the configuration file you wish to modify.

b. Set the `EXPORT` and `IMPORT` fields to zero.

NOTE You cannot set `EXPORT` to 0 for the `OTHERS` group.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners’ initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM’s memory manager if it is not already enabled:

```
# prmconfig -e MEM
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Controlling disk bandwidth

You can add, modify, or delete disk bandwidth shares for each PRM group as discussed in the following sections:

- “Adding/modifying disk bandwidth shares” on page 124
- “Removing disk bandwidth shares” on page 125

NOTE To take advantage of PRM’s disk bandwidth management, your disks must be under the control of HP’s Logical Volume Manager (LVM) or of VERITAS Volume Manager (VxVM). If you would like to use disk bandwidth management, see “Setting up your disks” on page 85.

Disk bandwidth record syntax

You can specify a group’s disk bandwidth shares for a given logical volume group (LVM) or disk group (VxVM) using disk records.

Disk records are optional. However, if one FSS PRM group has a disk record for a volume group/disk group, then all FSS PRM groups must have a disk record for that volume group/disk group. PSET PRM groups do not have disk records. PSET PRM groups are treated as part of `PRM_SYS` for disk bandwidth purposes.

NOTE Do not specify disk bandwidth records for configurations used inside virtual machines.

Specify a disk record using the syntax:

```
VOLUME:{ PRMID | GROUP }:SHARES::
```

where

`VOLUME`	Is the name of a logical volume group (LVM) or a disk group (VxVM). This name must begin with `/dev/v` to be recognized as a disk record.
`PRMID | GROUP`	Is an FSS PRM group ID or group name that corresponds to an existing group. When specifying parents in a group hierarchy, use their names.

`SHARES` Is the FSS PRM group disk bandwidth shares. Shares are expressed as integer values between zero and `MAXINT` inclusive.

Use zero shares as a place-holder for groups not using the volume group/disk group. The value is not literally zero: It does not block access to the volume group/disk group. However, if a group has zero shares, a five-second disk transaction could take over 30 minutes if the disk is busy.

The fourth and fifth fields of a disk record must be null.

Adding/modifying disk bandwidth shares

To add or modify a disk record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
VOLUME:{ PRMID | GROUP }:SHARES::
```

and explained in the section “Disk bandwidth record syntax” on page 123, add or modify a disk record as follows:

a. Specify the logical volume group, such as `/dev/vg01`, or disk group.

b. Specify the ID or group name of a PRM group, such as `databases/order`.

c. Specify the PRM group’s shares for the volume group/disk group.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`# prmconfig -i [-f configfile] {-s | -c}`

To keep the existing assignments of users, processes, and groups, use the command:

`# prmconfig -k [-f configfile] {-s | -c}`

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's disk bandwidth manager if it is not already enabled:

`# prmconfig -e DISK`

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

`# prmconfig -e`

Removing disk bandwidth shares

To remove a disk bandwidth record manually:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the disk bandwidth record you wish to remove. Disk bandwidth records have the following form:

```
VOLUME:{ PRMID | GROUP }:SHARES::
```

Step 3. Repeat Step 2 until all disk bandwidth records referencing `VOLUME` are removed if you no longer want `VOLUME` under PRM control.

Step 4. Ensure there is still a one-to-one correspondence between disk bandwidth records and group/CPU records if there are any disk bandwidth records still present in the configuration.

Step 5. Save the file and exit the text editor.

Step 6. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`# prmconfig -i [-f configfile] {-s | -c}`

To keep the existing assignments of users, processes, and groups, use the command:

`# prmconfig -k [-f configfile] {-s | -c}`

Use the `-f configfile` option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 7. Enable PRM's disk bandwidth manager if it is not already enabled:

`# prmconfig -e DISK`

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

`# prmconfig -e`

Controlling applications

You can specify the PRM group each application can run in as discussed in the following sections:

- Adding/modifying an application's group assignment

You can remove an application's group assignment as discussed in the following sections:

- Removing an application's group assignment

Duplicate application records

Be careful to avoid duplicating application records. A duplicate record specifies the same application and alternate name (if any) as another record, but uses a different PRM group. The application is the same if the file ID or pathname matches. The file ID is based on the file system device and inode number.

For example, in the records below, the two applications /usr/bin/mv and /bin/mv have the same underlying file ID, but are assigned to two different PRM groups. Because of the ambiguity, it is impossible to accurately predict which PRM group would get the application.

```
/usr/bin/mv::::GroupA
/bin/mv::::GroupB         # duplicate record
```

In the next example, the application is now /usr/bin/mv in both records. However, the alternate names cp and mv have been added to the records. These two records would be fine in the same configuration file if the first record had only mv as an alternate name. In that case, /usr/bin/mv would be placed in GroupA when invoked with the mv command and in GroupB when invoked with the cp command. However, with cp as an alternate name in both records, we have another ambiguity.

```
/usr/bin/mv::::GroupA,cp,mv
/usr/bin/mv::::GroupB,cp         # duplicate record
```

It is possible to add duplicate application records when editing a configuration file. This happens most often when working with large configuration files.

PRM checks for duplicate records when you load a configuration. If there are any duplicate records in a configuration file, trying to load the file produces errors. In this case, remove the duplicate records and load the configuration file again.

Missing applications are ignored

PRM ignores the application records for missing applications.

This functionality, as opposed to generating errors, is desirable when using a single configuration for multiple systems that have different applications installed.

Applications records are also ignored if they reference applications on filesystems that are not mounted at the time PRM is configured. Reload the PRM configuration with prmconfig when the filesystem is present for the application records to take effect.

Application record syntax

This section explains the application record syntax.

Application records assign applications to PRM groups. Each record specifies an application and the PRM group it and its child processes can run in. Application records are optional; if an application does not have a record, it runs in the PRM group of the user who invoked it.

Specify application records using the following syntax:

```
APPLICATION::::GROUP[,ALT_NAME[,...,ALT_NAME]]
```

where

`APPLICATION` Specifies the full pathname of an executable application, the shell/interpreter in the case of a script, or your Java binary—starting with a slash (/).

NOTE For scripts, the full path of the shell/interpreter used in the script must appear in either the file /etc/shells or the file /opt/prm/shells.

For Java programs, the path of the Java being used—as displayed in `ps` output—must appear in either /etc/shells or /opt/prm/shells. For an example, see “Launching a Java program under PRM” on page 138.

You can use wildcards (`[`, `]`, `?`, and `*`) to specify the filename, but not the directory name. For more information on wildcards in application filenames, see “Pattern matching for filenames” on page 63.

NOTE If a specified application does not exist, PRM generates a warning. This condition is a warning rather than an error so that you can use the same configuration file on multiple machines.

GROUP Is the name of the PRM group in which the application will run.

NOTE

If GROUP is in a hierarchy, it must be a leaf group (a group with no child groups). You cannot assign applications to parent groups. For example, in the configuration below, TWO is a parent group and TWO/b is a leaf group.

```
#Group records
TWO:HIER:60::
TWO/b:3:50::

#Application records
/opt/appname/bin/exec1::::TWO          # INVALID
/opt/appname/bin/exec2::::TWO/b        # VALID
```

Consequently, TWO cannot be used in an application record.

For more information on hierarchical groups, see "Hierarchical PRM groups" on page 38.

ALT_NAME (Optional) Is an alternate name for the application assigned at execution. This is common for complex programs such as database programs that launch many processes and rename them. It is also common for shells and interpreters used in scripts; the names of the scripts are considered alternate names.

Using alternate names, you can place the various processes of a single application in different PRM groups.

For most binaries and scripts, ALT_NAME should match the first item in the COMMAND column (that is, the command argument with no options) of the output from the `ps -ef` command. For Java programs, it should match the first argument to the Java binary that is not preceded by a dash (-) in the COMMAND column. For more information, see ps(1).

The alternate name must share the file ID of the application named in the record.

Pattern matching notation can be used to designate a group of similarly named processes. For more information on how to use wildcards and Extended Regular Expressions in alternate names, see “Pattern matching for renamed application processes” on page 63. For details on pattern matching expressions, see the regexp(5) manpage.

If `ALT_NAME` is not specified for a record, that record matches all processes with a file ID that matches the file ID of the application given by `APPLICATION`.

Consider the following example application records:

```
#PRM application records

/usr/bin/database:::business_apps,db_inventory,db_payroll
/usr/bin/database:::order_process,db_orders,order_report*
/opt/perl/bin/perl:::scripts,report_formatter.pl
/usr/bin/mail:::mailserver
```

The example shows application records for:

- Processes renamed db_inventory and db_payroll by the executable `/usr/bin/database` and assigned to the group `business_apps`.
- The process renamed db_orders by the executable `/usr/bin/database` and assigned to the group `order_process`.
- The perl script report_formatter.pl, which is assigned to the group `scripts`.
- The application `/usr/bin/mail`, which is assigned to the group `mailserver`.

Adding/modifying an application's group assignment

To add or modify an application's PRM group assignment, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
APPLICATION:::GROUP[,ALT_NAME[,...,ALT_NAME]]
```

and explained in the section "Application record syntax" on page 128, add or modify an application record as follows:

a. Specify the full pathname of the application.

b. Specify the group where the application should run.

c. Optionally, add or modify alternate names for the application.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`#` **`prmconfig -i [-f`** *`configfile`***`] {-s | -c}`**

To keep the existing assignments of users, processes, and groups, use the command:

`#` **`prmconfig -k [-f`** *`configfile`***`] {-s | -c}`**

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

If you change an application's group, using `prmconfig -i` resets all instances of the application and its child processes to run in the newly assigned group.

With `prmconfig -k`, typically all of the application's currently running processes continue to execute in their current groups until:

- A `prmmove` is executed
- The application is restarted
- The application manager moves any processes that are not in their assigned groups

However, `prmconfig -k` does move a currently running application if:

- It is running in the system group (`PRM_SYS`) and that is not its assigned group
- The group it is running in is deleted in the new configuration

For more information on these options, see Table 7-1 on page 154.

Step 5. Enable PRM's application manager if it is not already enabled:

```
# prmconfig -e APPL
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Example: Grouping an application by its alternate names and functions To place an application in the same group as its alternate names, add the application's name to the list of alternate names. For example, to put the main database program in the group `order_process`, add it to the list of alternate names in the record, as shown below:

```
#PRM application records

/usr/bin/database:::business_apps,db_inventory,db_payroll
/usr/bin/database:::order_process,db_orders,database
```

Example: Assigning a running application to another group

Assume the sales department purchased a new application called CustomerTrack to help them track their customer base. Because the application does not have a record, it runs in the group of the users that invoke it. Because everyone on the sales staff is assigned to the `sales` group, CustomerTrack runs in the `sales` group.

However, due to the importance of this application as a sales tool, the PRM administrator decides to assign it to the crit_apps group where it is assured sufficient resources.

The procedure to re-assign the application is outlined below.

Step 1. Open the desired configuration file in a text editor.

Step 2. Add an application record for CustomerTrack with crit_apps as the assigned group.

Step 3. Configure PRM using -k to keep the existing assignments of users, processes, and groups:

```
# prmconfig -k
```

Step 4. Wait for the application manager to automatically move the processes. This will take no longer than 30 seconds, the default length of the application manager polling interval. Alternatively, move the processes yourself as discussed below.

a. Find the process ID for CustomerTrack using the ps command:

```
# ps -efP | grep CustomerTrack

UID       PRMID   PID   PPID  C    STIME   TTY TIME   COMMAND
root      PRM_SYS 4435  4220  6 15:16:21 ttyp2 0:00   grep CustomerTrack
advisor4  sales   4418  4220  4 15:11:18 ttyp2 0:00   CustomerTrack
```

b. Move the CustomerTrack process and all its child processes by process group PID to the PRM group crit_apps using prmmove:

```
# prmmove crit_apps -g 4418
```

Step 5. Verify that CustomerTrack is running in the crit_apps group by using the ps command:

```
# ps -PR crit_apps

PRMID          PID      TTY      TIME    COMMAND
crit_apps      4418     ttyp2    0:00    CustomerTrack
crit_apps      4485     ttyp2    0:00    CustomerOrder
crit_apps      4492     ttyp2    0:00    Issue
```

Removing an application's group assignment

To remove an application record with a text editor:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the application record you wish to remove. Application records have the following form:

```
APPLICATION:::GROUP[,ALT_NAME[,...,ALT_NAME]]
```

NOTE You may have multiple records for a single application. Be sure to locate all records for an application in the configuration file and remove the appropriate records.

Step 3. Save the file and exit the text editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

```
# prmconfig -e APPL
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Launching an application under PRM

There are two ways to start an application under PRM:

- Start the application as you normally would.

  The application manager automatically moves it to the PRM group assigned in the PRM configuration file. A user must have the correct permissions to run the application.

- Use the `prmrun` command. For example, to start the `critical_app` application in its assigned group `CriticalApp`:

  `#` **`prmrun critical_app`**

  The PRM configuration file must contain one record that has no alternate process names for this application. If there is no such record, `prmrun` fails with an error.

  The `prmrun` command allows any user to run an application in its assigned group as defined in the PRM configuration file, assuming the user has execute permission on the application. This means that any user can execute this command, even if they do not have permission to use the application's assigned PRM group.

  The `prmrun -g` command can be used to override the PRM configuration file and run the application in a specific PRM group if the user has access to the PRM group.

If the application manager is not running, and you do not use `prmrun` to start the application, it runs in the current PRM group of the user who invokes it.

When the application manager is enabled, any applications not running in their assigned PRM groups are moved to their assigned groups. The exception is an application moved to a specific PRM group with `prmmove -g` or one started in a specific group with `prmrun -g`. If an application does not have an assigned PRM group, it runs in the group of the invoking user.

Launching an application in its assigned group To launch an application in its assigned PRM group, you have two options:

- Start the application, then wait 30 seconds (the application manager's default interval) to allow it to place the application in its assigned group
- Follow the steps below:

Step 1. Ensure the application has an assigned PRM group. If not, edit the PRM configuration file by adding a record as explained in the section "Controlling applications" on page 126.

Step 2. Execute `prmconfig -k` or `prmconfig -i` to update the configuration and start the application manager if necessary.

Step 3. Start the application using the `prmrun` command:

```
# prmrun application
```

Launching an application in a user-specified group You can allow an application to run in its assigned PRM group, or you can use the `prmrun` command to force the application to run in another group.

For example, to run the application CustomerOrder in the `sales` PRM group, execute the command:

```
# prmrun -g sales CustomerOrder
```

Permissions are checked to ensure the user executing the command can access the PRM group `sales`. If the user does not have the group listed as the initial group or an alternate group in the configuration file, an error condition occurs. The user must also have execute permission on the application.

This command enables users to run applications in alternate PRM groups if they have permission to do so. This command is useful for users with alternate groups and for root users.

To find out what PRM groups a user has access permission to, the user can enter the `prmrun` command without any arguments:

```
# prmrun
```

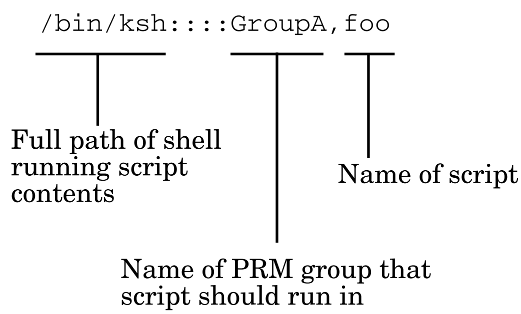
```
User Bob can access the following:
     sales
     accounting
```

Launching a script under PRM

To always run a script in a specific PRM group, use an application record. In this record, specify the full path of the shell or interpreter used in the script as the application. Also, give the name—without the path—of the script as an alternate name.

For example, consider a script named foo that uses `ksh` to execute its contents. In this scenario, an application record might look like this:

Figure 7-1 Application record for a shell script



NOTE The full path of the shell/interpreter used in the script must appear in either the file /etc/shells or the file /opt/prm/shells.

Because the full pathname is not required for the script, a rogue user can get access to PRM groups—that otherwise would not be accessible— by using the name of the script for new scripts or wrappers.

If the script is not regularly used or is under development, you can use `prmrun` or `prmmove` to place it in a PRM group. To have the script place itself in a PRM group, add the following line to the script:

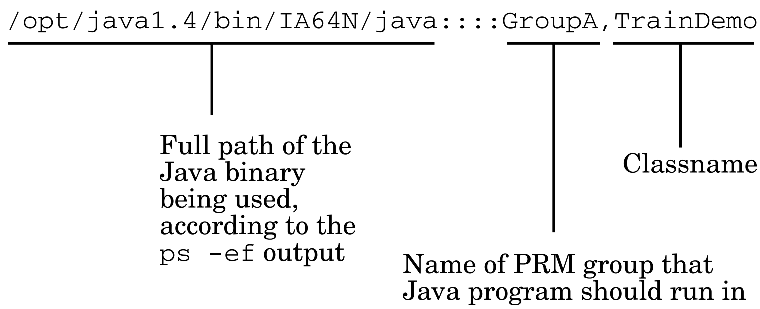
`prmmove -p $$` *`group_name`*

Launching a Java program under PRM

To always run a Java program in a specific PRM group, use an application record. In this record, specify the full path of the Java binary as the application. Also, give the classname as an alternate name. (Specifically, the alternate name you specify should match the first argument to the Java binary that is not preceded by a dash (–) in the `COMMAND` column of the `ps -ef` output.)

For example, consider a Java program run with classname TrainDemo. In this scenario, an application record might look like this:

Figure 7-2 Application record for a Java program



NOTE The full path of the Java binary used must appear in either the file /etc/shells or the file /opt/prm/shells.

For more information on specifying Java programs in application records, see “Application record syntax” on page 128.

Specifying PRM users

You can add, modify, and remove users' PRM group assignments as discussed in the following sections:

- "Adding/modifying a user's group assignment" on page 142
- "Removing a user's group assignment" on page 144

PRM integrates with NIS by allowing you to specify netgroups in user records. For more information on NIS, see the ypfiles(4) manpage.

NOTE The processes of any nonroot user who does not have a user record are placed in the default user group `OTHERS` (PRMID 1). If this placement is acceptable for a given user, do not create a user record for that user name. If there is no user record for root, the record is automatically created, placing root processes in the group `PRM_SYS` (PRMID 0).

User record syntax

This section explains the syntax of user records.

User records specify PRM users and the groups they can access.

Use the following syntax when specifying a user record:

```
USER::::INITIALGROUP[,ALTERNATEGROUP[, ...]]
```

where

`USER`

Is one of the following:

- A user's login name

  This name must correspond to the user's name in password files that can be accessed by the C function `getpwnam`, such as /etc/passwd.

  If you assign processes that would typically run in `PRM_SYS` to another group, be sure that group has sufficient resources. (For example, if you are using memory records, be sure the group gets enough memory.) Take particular care when creating user records for root as such records will move essential system processes, such as `inetd`.

- +*netgroup_name*

  netgroup_name must correspond to a list of login names in /etc/netgroup. When a configuration is loaded, any user in *netgroup_name* who does not have an explicit user record assumes the `INITIALGROUP` and any `ALTERNATEGROUP`s of this record.

  If a user who does not have an explicit user record is in multiple netgroups, each with its own user record, the `INITIALGROUP` of the first matching record (based on an ASCII dictionary sort) becomes the user's initial PRM group. All other groups become alternate groups.

  If a user has an explicit user record and is in one or more netgroups that have user records, the explicit record takes precedence.

  PRM ignores any line in /etc/netgroup that has an empty user field.

NOTE PRM only checks netgroup definitions when a configuration is loaded. If you change your netgroup definitions, reload your configuration so PRM is aware of the new definitions.

For an example of how netgroups affect PRM group assignments, see "Displaying netgroup expansions" on page 176.

`INITIALGROUP`

Is the name of the initial PRM group for the user or netgroup. This is the group the `login` program chooses when launching the user's login shell. Also, it is the group that `cron` chooses when scheduling jobs for the user.

`ALTERNATEGROUP`

Is the name of one of the alternate PRM groups for the user or netgroup. Alternate groups are groups other than the initial group that the user or netgroup members are allowed to run processes in. The user or netgroup members can start a process in an alternate group using `prmrun` or can move an existing process to an alternate group using `prmmove`.

Alternate groups are not meaningful for root users because they have access to all PRM groups.

NOTE If `INITIALGROUP` or `ALTERNATEGROUP` is in a hierarchy, it must be a leaf group (a group with no child groups). You cannot assign users to parent groups. For example, in the configuration below, `TWO` is a parent group and `TWO/b` is a leaf group.

```
#Group records
TWO:HIER:60::
TWO/b:3:50::

#User records
user1::::TWO            # INVALID
user2::::TWO/b          # VALID
```

Consequently, `TWO` cannot be used in a user record.

For more information on hierarchical groups, see “Hierarchical PRM groups” on page 38.

User records for nonroot users cannot contain the name of the PRM system group, `PRM_SYS`.

The second, third, and fourth fields of a user record must be null.

Consider the following example user records:

```
#PRM user records

sysadm::::OTHERS
engineer1::::development,OTHERS
user1::::OTHERS
user2::::sales
+marketing::::mktg
```

These user records define:

- An initial group of `OTHERS` for root user `sysadm`. (Recall that all root users have implicit access rights to all groups.)
- An initial group of `development` and alternate group `OTHERS` for `engineer1`.
- An initial group of `OTHERS` for `user1`.
- Assuming `user2` is in the `marketing` netgroup, the explicit user record for `user2` takes precedence over the `marketing` netgroup's user record. Consequently, `sales` is the user's initial PRM group.

Adding/modifying a user's group assignment

To add or modify a user record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
USER::::INITIALGROUP[,ALTERNATEGROUP[, ...]]
```

and explained in the section "User record syntax" on page 139:

a. Add or modify a line specifying a netgroup or a user's login name.

b. Add or modify an initial group.

c. (Optional) Add or modify the alternate groups.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`# prmconfig -i [-f configfile] {-s | -c}`

To keep the existing assignments of users, processes, and groups, use the command:

`# prmconfig -k [-f configfile] {-s | -c}`

Use the `-f configfile` option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

NOTE If you change a user's initial group, using `prmconfig -i` resets the user's processes. With `prmconfig -k`, all of the user's currently running processes continue to execute in their current group until a `prmmove` is done or until the user logs in again. Any other processes continue to run in their current group unless moved with `prmmove`. For more information on these options, see Table 7-1 on page 154.

Step 5. Enable PRM's application manager if it is not already enabled:

`# prmconfig -e APPL`

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

`# prmconfig -e`

Example: Changing the initial group of a user Consider this scenario in which a user's initial group is changed. One of the sales advisors, `advisor6`, has decided to change jobs and move to the purchasing department. The user's login does not change. However, in the PRM configuration file, `advisor6` needs to be added to the `purchasing` group and removed from the `sales` group. Also, the number of shares for the user's original and new groups need to be modified to meet each group's anticipated resource needs.

One way to accomplish this change is to:

Step 1. Update the configuration file in a text editor as follows:

a. Modify the number of shares for the `purchasing` and `sales` groups.

b. Modify the user record for `advisor6` to specify an initial group of `purchasing`.

Step 2. Load the updated configuration using `-k` to keep the existing assignments of users, processes, and groups:

```
# prmconfig -k
```

Step 3. Move all currently running processes for `advisor6` to the PRM group `purchasing` using `prmmove`:

```
# prmmove purchasing -u advisor6
```

Removing a user's group assignment

To remove a user record manually:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the user record you wish to remove. User records have the following form:

```
USER:::INITIALGROUP[,ALTERNATEGROUP[, ...]]
```

Step 3. Save the file and exit the text editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

```
# prmconfig -e APPL
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Assigning secure compartments to PRM groups

Use the HP-UX feature Security Containment (available starting with HP-UX 11i v2) to create secure compartments, which isolate files and processes. (You can also create secure compartment configurations using a PRM utility such as `srpgen` or `prm2scomp`.)

You can add, modify, and remove assignments of secure compartments to PRM groups as discussed in the following sections:

- "Adding/modifying a compartment's group assignment" on page 147
- "Removing a compartment's group assignment" on page 148

Compartment record syntax

This section explains the syntax of compartment records.

Compartment records assign secure compartments to the groups.

Use the following syntax when specifying a compartment record:

```
#!SCOMP:COMPARTMENT_NAME:{GROUP | (NONE)}
```

where

`#!SCOMP`

Indicates the start of a compartment record. (The # character does not denote the start of a comment in this case.)

COMPARTMENT_NAME

Is the alphanumeric name (of no more than 255 characters) of an existing secure compartment that you created using the HP-UX feature Security Containment. (You can also create these compartments using a PRM utility such as `srpgen` or `prm2scomp`.) The compartment must be active.

A compartment can have no more than one record.

This record type takes precedence over application records and user records.

GROUP

The PRM group to which the secure compartment is to be mapped. If you are using group hierarchies, the group you specify must not have any child groups.

(NONE)

You can specify `(NONE)` in place of a group name if you would like to explicitly show in your configuration file that a compartment is not to be mapped to a PRM group.

Consider the following example compartment records:

```
#PRM compartment records

#!SCOMP:Comp1:development
#!SCOMP:Comp2:sales
#!SCOMP:Comp3:mktg
```

These compartment records map:

- The compartment Comp1 into the group `development`
- The compartment Comp2 into the group `sales`
- The compartment Comp3 into the group `mktg`

Adding/modifying a compartment's group assignment

To add or modify a compartment record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
#!SCOMP:COMPARTMENT_NAME:{GROUP | (NONE)}
```

and explained in the section "Compartment record syntax" on page 145:

a. Add or modify a line specifying a compartment name.

b. Add or modify the group—or replace it with `(NONE)`.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

prmconfig -i [-f *configfile***] {-s | -c}**

To keep the existing assignments of users, processes, and groups, use the command:

prmconfig -k [-f *configfile***] {-s | -c}**

Use the `-f` *configfile* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

prmconfig -e APPL

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

prmconfig -e

Removing a compartment's group assignment

To remove a compartment record manually:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the compartment record you wish to remove. Compartment records have the following form:

```
#!SCOMP:COMPARTMENT_NAME:{GROUP | (NONE)}
```

Step 3. Save the file and exit the text editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

```
# prmconfig -e APPL
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Assigning Unix groups to PRM groups

Unix groups are collections of users given Unix permissions as a whole. PRM allows you to map Unix groups to PRM groups without having to specify each user in the Unix group. With a Unix group record, any process running as a specific Unix group can be assigned to a PRM group.

You can add, modify, and remove assignments of Unix group to PRM groups as discussed in the following sections:

- "Adding/modifying a Unix group's PRM group assignment" on page 151
- "Removing a Unix group's PRM group assignment" on page 152

Unix group record syntax

This section explains the syntax of Unix group records.

Unix group records assign Unix group to PRM groups.

Use the following syntax when specifying a Unix group record:

```
#!UXGRP:UNIX_GROUP_NAME:{GROUP | (NONE)}
```

where

`#!UXGRP`

Indicates the start of a Unix group record. (The # character does not denote the start of a comment in this case.)

`UNIX_GROUP_NAME`

Is the alphanumeric name (of no more than 255 characters) of an existing Unix group.

A Unix group can have no more than one record.

This record type yields precedence to application records, compartment records, and user records.

`GROUP`

The PRM group to which the Unix group is to be mapped. If you are using group hierarchies, the group you specify must not have any child groups.

`(NONE)`

You can specify `(NONE)` in place of a group name if you would like to explicitly show in your configuration file that a Unix group is not to be mapped to a PRM group.

Consider the following example Unix group records:

```
#PRM Unix group records

#!UXGRP:finance_dept:finance
#!UXGRP:users:(NONE)
#!UXGRP:mail:tools/mail
```

These Unix group records map:

- The Unix group finance_dept into the group `finance`
- The Unix group users into the placeholder `(NONE)`
- The Unix group mail into the group `tools/mail`

Adding/modifying a Unix group's PRM group assignment

To add or modify a Unix group record, follow these steps:

Step 1. Open the desired configuration file in a text editor.

Step 2. Using the syntax shown below:

```
#!UXGRP:UNIX_GROUP_NAME:{GROUP | (NONE)}
```

and explained in the section "Unix group record syntax" on page 149:

a. Add or modify a line specifying a Unix group name.

b. Add or modify the group—or replace it with `(NONE)`.

Step 3. Save the file and exit your editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

```
# prmconfig -e APPL
```

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

```
# prmconfig -e
```

Removing a Unix group's PRM group assignment

To remove a Unix group record:

Step 1. Open the configuration file in a text editor.

Step 2. Remove the line corresponding to the Unix group record you wish to remove. Unix group records have the following form:

```
#!UXGRP:UNIX_GROUP_NAME:{GROUP | (NONE)}
```

Step 3. Save the file and exit the text editor.

Step 4. Load the configuration using one of the following commands:

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

`# prmconfig -i [-f configfile] {-s | -c}`

To keep the existing assignments of users, processes, and groups, use the command:

`# prmconfig -k [-f configfile] {-s | -c}`

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 5. Enable PRM's application manager if it is not already enabled:

`# prmconfig -e APPL`

Alternatively, enable all PRM resource managers using `prmconfig -e` without any additional arguments:

`# prmconfig -e`

Checking the configuration file

Use `prmconfig -s` to perform validation without changing the current PRM configuration. This can be helpful to validate a configuration file that will be activated by a script at a later time. To specify a configuration file other than /etc/prmconf, use `prmconfig -s -f` *`configfile`*.

Validation checks for:

- Duplicate group names
- Duplicate user names
- Undefined groups in user access lists
- Mismatches between the users listed in the configuration file and the logins in the password files accessible by the C function `getpwnam`

The checks are made when you save or load a configuration file.

Warnings reported in the check may indicate an invalid configuration. These warnings do not prevent you from loading the configuration and enabling PRM. For example, you may not specify all users in the PRM configuration file and mismatches may exist, but the file is still valid. Users not specified in the PRM configuration file use the user default group `OTHERS` (PRMID 1) as their initial group, and they have no alternate groups.

Loading the PRM configuration

Once you plan your configuration, install PRM, and create your custom configuration file, you are ready to load your configuration.

Neither the `prmconfig` options for loading a configuration nor the GUI equivalents start PRM management of resources; they only load your specific configuration. All existing and newly spawned processes are stamped with their PRM group identifiers. However, standard HP-UX is still managing resource allocation. `prmconfig` and the corresponding GUI menu items can be executed regardless of whether PRM or the standard HP-UX resource management is currently being used.

When you load a configuration with `prmconfig -i`, `prmconfig -k`, or the GUI equivalents, the configuration file is checked for errors. If errors are found, PRM issues error messages, and does not change the configuration. Errors in the configuration file must be corrected before PRM can be configured and enabled.

When the prmconfig -i, prmconfig -k, or GUI equivalents complete without finding errors, an internal copy of the configuration file is made. This copy is used by the PRM commands as well as the PRM-aware HP-UX commands while PRM is configured. (For information on these PRM-aware commands, see “HP-UX command/system call support” on page 231.) Thus, the original configuration file can be edited without disrupting PRM. However, to be safe, you should create a work copy to make modifications to the configuration file.

If a PRM configuration is not already loaded, using either prmconfig -i or prmconfig -k (or the GUI equivalents) moves all currently running processes, not owned by any root user, to their owners’ initial groups. However, if a user’s initial group is not defined in the configuration file or there is no record for the user, the processes are placed in OTHERS (PRMID 1), the user default group. This occurs even if the PRM scheduler has not been enabled. Any configured application is moved to the group assigned in the PRM configuration file.

If a PRM configuration is already loaded and some processes have been moved to alternate groups, the two types of configuration loads have different results, as shown in Table 7-1.

Table 7-1 Differences in loads when a configuration is already loaded

Command	Description
prmconfig -i (Initialize or Move)	Loads a PRM configuration as follows: • Places processes subject to compartment, application, user, or Unix group records in their assigned PRM groups. • Places all currently running processes—not owned by root—in their owners’ initial groups, as defined in the owners’ user records. The initial group is OTHERS for nonroot users without user records. If root has a user record, root logins that occur after the load are placed in the PRM group specified as the initial group in the user record. However, any root processes that exist when the load happens are left as is, unless the process is executing in a group that is deleted in the new configuration, in which case, the processes are moved to the specified initial group.

Table 7-1 Differences in loads when a configuration is already loaded

Command	Description
`prmconfig -k` (Keep)	Loads a PRM configuration, keeping all processes in their current PRM groups, with the following exceptions: • User processes running in `PRM_SYS` (the PRM system group) and processes running in groups that do not exist in the new configuration Each process is moved to the initial group of the process owner, as defined in the configuration file. The initial group is `PRM_SYS` for root users without user records. The initial group is `OTHERS` for nonroot users without user records. • User processes where the initial group is a PSET PRM group—and at least one PSET group in the configuration has specific cores assigned to it Each process is moved to the initial group of its user as defined in the configuration file. • Application processes matching application records running in `PRM_SYS` or in a PSET PRM group—and at least one PSET group in the configuration has specific cores assigned to it These processes are moved to the assigned groups when the application manager is enabled. This load does not negate any previous `prmrun` or `prmmove` commands.

Loading the PRM configuration with `prmconfig`

When loading a configuration, you have two options. To initialize on the load of a configuration, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

NOTE After you load your configuration, you can enable PRM, as discussed in "Enabling resource managers" on page 156.

Enabling resource managers

Enable PRM's resource managers after you load your configuration.

NOTE Before or after enabling PRM, you can fine-tune your configuration. See the chapter "Fine-tuning your PRM configuration" on page 161 for details.

Enabling resource managers with `prmconfig`

To start all PRM resource managers (CPU, memory, disk bandwidth, and application), enter the following command:

```
# prmconfig -e
```

If there are no memory records, the memory manager is not started. However, even if there are no application records, the application manager does start. Also, the disk bandwidth manager starts—even when there are no disk records—if you specify `prmconfig -e DISK`; this allows you to perform monitoring.

The `prmconfig -e` command controls only whether the PRM resource management is being used and does not change the configuration. However, PRM must be configured (have a configuration loaded) for this option to be valid.

When PRM is enabled, it takes precedence over standard HP-UX resource management when the system is at peak load.

If you wish to enable PRM for one type of resource only, specify the appropriate keyword as shown in Table 7-2.

Table 7-2 Enabling specific resource management on the command line

To enable PRM for	Enter
CPU management only	`# prmconfig -e CPU`
Disk bandwidth management only	`# prmconfig -e DISK`
Memory management only	`# prmconfig -e MEM`
Application management only	`# prmconfig -e APPL`
CPU capping for all FSS PRM groups (For information on per-group capping, see “Group/CPU record syntax” on page 105.)	`# prmconfig -e CPU -M CPUCAPON`

NOTE You must enable the application manager to enforce application records, user records, compartment records, and Unix group records.

Updating the configuration

To update your configuration, simply change your configuration file and load it. You do not need to disable or reset PRM to make changes to your PRM configuration.

For small changes you can bring the configuration file into a text editor or a GUI, make the changes, save the file, and then load the configuration with `prmconfig` or a GUI.

If you are adding a large number of new users to the configuration file, you can use `prmloadconf` to add the users for you. For each user in the password file not already specified in the configuration file, `prmloadconf` appends a PRM user record to the configuration file. The added record specifies the user's login name from the password file and the placeholder `(NONE)` instead of a PRM group. After using `prmloadconf`, you may want to modify the user's initial group and add alternate groups. After changing the configuration file, you must still load the configuration using either `prmconfig` or a GUI.

When using `prmloadconf`, if the configuration file already exists, elements of the existing file are checked for suitability (such as the presence of the user default group). Use the `-f` option to specify a configuration file other than /etc/prmconf.

If the new configuration deletes a group, then all currently running processes that were associated with that group are moved to the owner's initial group, and to the assigned groups for configured applications. If a process owner does not have an initial group or its group does not exist in the new configuration, the process is moved to the user default group `OTHERS` (PRMID 1). If the owner of a process running in a group that is deleted is a root user, the process is moved to the system group. The system group, `PRM_SYS` (PRMID 0), is automatically created by PRM, and system processes run there by default.

Change your configuration file then load the new configuration, as indicated in the following steps:

Step 1. Change the configuration using `prmloadconf` or as explained in "Configuring PRM" on page 99.

Step 2. Load the configuration using one of the following commands.

To initialize, moving user processes to the owners' initial groups and moving applications to their assigned groups, use the command:

```
# prmconfig -i [-f configfile] {-s | -c}
```

To keep the existing assignments of users, processes, and groups, use the command:

```
# prmconfig -k [-f configfile] {-s | -c}
```

Use the `-f` *`configfile`* option to specify a file other than the default /etc/prmconf. The `-s` option displays warnings regarding the configuration file. (The `-c` option displays a subset of the `-s` warnings.)

Step 3. Enable resource managers if they are not already enabled:

```
# prmconfig -e
```

8 Fine-tuning your PRM configuration

This chapter describes the optional step of fine-tuning your PRM configuration.

To adjust your configuration, you may need to perform several iterations of identifying resource use and assigning groups. Fundamentally, you need to understand what processes are run by what users and the percentages of resources they consume. How you collect this data depends on how your processes or system load varies from day to day.

You can use the following tools to track resource use:

- PRM monitor (accessed by the `prmmonitor` command) shows the percentage of CPU, memory, and disk bandwidth resources allocated to and used by PRM groups.
- `prmanalyze` analyzes accounting files for data on resource usage and contention.
- PerfView Analyzer analyzes how your system resources are used over time.
- GlancePlus pinpoints resource use in real-time and sets alarms.
- `acctcom` displays process accounting record information.
- PRM memory message logging.

This chapter discusses the use of `prmanalyze`, GlancePlus, and message logging.

Using `prmanalyze` to analyze your configuration

The `prmanalyze` utility scans accounting files for information on the desired resource type (disk, memory, or CPU) and orders the accounting records by the requested sort key (user, UNIX group, command name, or PRMID). Use `prmanalyze` to find patterns in resource usage, then change your PRM configurations accordingly.

In addition, you can use `prmanalyze`—even when you are not using PRM—to perform resource use analysis and capacity planning.

Use `prmanalyze -f` to list which features are available to PRM, such as in-kernel memory controls and processor sets.

With `prmanalyze`, you can generate three classes of reports:

- Summary

  This report is the default. It shows who consumes the resources and what the averages are from a high level. It can help you identify what user or applications need to be restrained or guaranteed more resources.

  Use this report when creating a new PRM configuration.

  The command to generate this report: `prmanalyze -t summary`

- Time-based (hourly, daily, weekly, monthly)

  These reports provide data on resource use over a given time period for all the available accounting data. These reports can help you determine what part of the day (hour, week, or month) each resource is most used. They also identify the users and applications involved in the resource consumption.

  Use these reports when enhancing an initial configuration to give special attention to users or applications. Also use these reports when creating multiple configurations to implement at different times over a given interval.

  The command to generate these reports:
  `prmanalyze -t {hourly | daily | weekly | monthly}`

- Conflict

  This report provides the most detail, highlighting only the instances where resources are scarce and users are in conflict.

  Use this report when fine-tuning a configuration. This report catches items that are missed by the time-based reports. After identifying conflicts, determine how much resource each PRM group needed during each conflict. Then determine what percentage of the resource the PRM group actually received. With this data, you can locate users and applications that are not getting as much of the resource as they should. You can also locate the parties involved most often and least often in the conflicts.

  The command to generate this report: `prmanalyze -t conflict`

This section focuses on certain `prmanalyze` functionality. Command options are used, but not described, in this section. For syntax information, see the section "`prmanalyze`" on page 203.

NOTE The examples below are for illustrative purposes only. They are not from an actual machine. The "summary report" is omitted from the examples below to better focus on the other reports.

The examples assume you have an existing PRM configuration that you want to improve. The `prmanalyze` utility can also be used to create an initial PRM configuration, as shown in "Using `prmanalyze` to quickly identify resource use" on page 81.

NOTE To use `prmanalyze`, you must have already collected UNIX accounting data in a file (/var/adm/pacct by default) using `accton` *`filename`*.

Example: Locating system bottlenecks

The first example shows how one might locate system bottlenecks and fine-tune a configuration with the aid of `prmanalyze` special reports.

Many of the interactive users assigned to the group `OTHERS` have complained that the system response time is terrible in the afternoons. The administrator examines the summary reports generated by `prmanalyze`, but sees nothing out of the ordinary. The administrator then looks more closely at CPU resource use:

```
# prmanalyze -r cpu -1 -t hourly -s prmid myacct
```

The CPU hourly report, however, is normal. The `OTHERS` group is getting plenty of CPU resources at all times. It has shares equaling 25%, but never demands more than 15%. So CPU resources are not the problem. Next, examine memory:

```
# prmanalyze -r mem -E -1 -t hourly -s prmid myacct
```

The memory report does show that `OTHERS` is peaking out on memory use around 3pm. The administrator then generates the same memory report, filtering out the known applications:

```
# prmanalyze -r mem -E -1 -t hourly -x web_browser -x
financials -x mrkt_rsch -x sales_fcst myacct
```

```
sorting chronological events
hourly memory report by command name begins at Wed Jul  7 15:27:00 1999

ave KB mem threshold 0.01

        unique id          ave KB     peak KB    KB minutes  % total

Jul  7 15:00             51976.33   1.725E+05     3.119E+06

        mail_reader       1082.25   3.861E+03     6.494E+04     2.08
        java               608.99   1.107E+03     3.654E+04     1.17
        debugger         50031.32   1.678E+05     3.002E+06    96.26
```

This report shows a debugger application consuming almost all the memory in `OTHERS`. This prevents other users from getting useful work done. The administrator can use `acctcom` to find the user running the debugger. If this user is a developer trying to locate a bug in the sales database program, change the user record to place him in the `Sales` group. If he is unrelated to any of the other activities on the machine, a separate group with low CPU/memory shares (taken from the OTHERS allocation) and a memory cap might be in order.

Example: High-level views of usage

The next example assumes a new multiprocessor machine in a university environment. One way to get a very high-level view of usage is to request a weekly or monthly report, setting the threshold so high that no details come out. Because HP-UX limits accounting files to two Mbytes, several files may need to be specified:

```
# prmanalyze -t weekly -d 16 *.acct98 Jan.acct99 Feb.acct99
```

```
weekly CPU report by command name begins at Thu Nov  5 13:48:00 1998

ave CPUs threshold 16.0

        unique id        ave CPUs   peak CPUs    total secs  % total

Nov  1                       0.00        0.00          0.00
Nov  8                       0.00        0.02          1.61
Nov 15                       0.01        1.11       4132.40
Nov 22                       0.02        1.08      14136.57
Nov 29                       0.02        1.53       9202.16
Dec  6                       0.03        1.73      21125.86
Dec 13                       0.02        0.75      14656.94
Dec 20                       0.00        0.88        739.48
Dec 27                       0.00        0.66       1243.89
Jan  3                       0.00        0.63       2589.75
Jan 10                       0.08        2.05      46000.07
Jan 17                       0.09        7.58      53873.11
Jan 24                       0.06        7.58      35398.47
Jan 31                       0.07        9.34      68588.17
Feb  7                       0.09       12.24     119510.85
```

One can see a definite progression here. Users gradually learn about the new machine and try it out in 1998, with usage slacking over the holiday break. Then, at the start of the first 1999 semester, usage increases dramatically. At this rate, all 16 cores will be busy by next week. The administrator needs to take definite steps to ensure all user groups have a fair portion of the machine. Perhaps the department should even consider ordering another system for the classes in question.

Example: Checking for patterns and configuration accuracy

In the following example, we assume a single-core system. Every so often, it is a good idea to examine daily reports for patterns and configuration accuracy. For reports on recent data, it is a good idea to add the -p flag to catch jobs that never exit or that run for several days:

```
# prmanalyze -s prmid -r cpu -p -t daily -x 0 filename
```

```
daily CPU report by PRM id begins at Thu Jul  8 10:11:00 1999

ave CPUs threshold 0.01

        unique id        ave CPUs   peak CPUs    total secs  % total

Jul  8                       0.20        0.89      17280.72

          1                  0.02        0.55       1195.84    11.59
          2                  0.09        0.88       7439.40    43.08
          3                  0.05        0.56       4116.09    23.82
          4                  0.01        0.14       1226.88     7.11
          5                  0.03        0.17       2479.65    14.36

Jul  9                       0.22        0.87      19008.00

          1                  0.02        0.60       2208.72    11.62
          2                  0.09        0.87       7890.23    41.51
          3                  0.06        0.60       4833.73    25.43
          4                  0.01        0.15       1699.32     8.94
          5                  0.02        0.14       2442.53    12.85

Jul 10                       0.09        0.88       7996.40

          1                  0.00        0.10        193.63     2.42
          2                  0.09        0.88       7348.53    91.89
          3                  0.00        0.08        180.96     2.26
          4                  0.00        0.04        198.73     2.48
          5                  0.00        0.01         74.50     4.15
```

This daily report indicates that the CPU resources are idle most of the time for this period. This is normal for a business that only uses its computers from 9am to 5pm. During the week, the CPU resource usage does not vary by more than about 10%, which is a good indication that the current configuration is working. However, the report for Saturday, July 10th has what appears to be an anomaly. Group 2 is taking up almost all the machine! Upon closer examination though, the administrator finds that the total seconds used is about the same as every other day, but all the other groups went virtually idle on the weekend. This application might be able to do its job even faster if we took off the memory cap for group 2 only on the weekends. Because there is no contention, a second configuration file could be created to repeal all memory records and change the CPU allocations for the weekend.

Another item to note in the report is that group 1 (OTHERS) has bursts of high activity relative to its normal levels. It may be worthwhile to do a CPU conflict report, excluding known applications, to see who the offender is:

```
# prmanalyze -s command -r cpu -t conflict -1 -d .4 -x mrkt_rsch -x financials

conflict CPU report by command name begins at Thu Jul  8 10:11:00 1999

ave CPUs threshold 0.40

        unique id         ave CPUs   peak CPUs    total secs  % total

Jul  8  8:35 -
Jul  8  9:17                  0.58        0.80       6102.48

        mail_reader           0.50        0.56       5331.36    87.36
        java                  0.06        0.20        578.52     9.48
        vi                    0.02        0.09        155.52     2.55
```

It seems that in the morning, and then again after lunch, everyone in OTHERS is busy reading mail. The administrator can track this usage. If it gets out of hand, the administrator can then isolate mail_reader to its own PRM group.

Example: Disk bandwidth

In the final example, mrkt_rsch users complain their report is taking too long to generate. Using methods already outlined, the administrator re-examines disk policy. The summary reports show that dump backup takes over 90% of the disk bandwidth for the day. What happens if we look for conflicts in disk usage without the interference of dump? We set the conflict threshold at four Mbytes/second because our primary disk volume group can service somewhere between four and eight Mbytes per second, depending on the type of I/O. We exclude the financials application because it runs in the Finance group, and has a disk of its own.

```
# prmanalyze -r disk -x dump -1 -t conflict -E -x financials \
-d 4194304 pacct.3

conflict disk report by command name begins at Wed Jul  7 15:27:00 1999

ave Bps disk threshold 4194304.00

        unique id          ave Bps    peak Bps      total KB  % total

Jul  7 16:20 -
Jul  7 17:00            5.242E+06   7.993E+06     1.229E+07

        cp              2.092E+05   5.324E+05     4.903E+05     3.99
        mrkt_rsch       1.397E+06   3.734E+06     3.602E+06    29.32
        rm              3.056E+05   3.815E+05     7.163E+05     5.83
        sales_fcst      4.503E+05   5.404E+05     1.055E+06     8.59
        sort            2.841E+05   3.978E+05     6.660E+05     5.42
        web_browser     2.142E+06   7.981E+06     5.021E+06    40.86
```

The `mrkt_rsch` job was initially timed stand alone on the system, but is now getting less than one-third, making the report take over three times as long to print. This delay has the side effect of taking up memory for a longer period as well.

Clearly, the culprit is the web browser doing file transfers over the net at an inopportune time. One solution is to give the critical market research application a disk of its own. However, while waiting for the new disk to arrive, the administrator can throttle the `web_browser` application using disk bandwidth records in PRM. Using the summary report with dump data filtered out (`-x dump`), the administrator creates a new PRM configuration to implement until the new disk arrives. The new configuration allocates little, if any, bandwidth on the common disks to the `Finance` PRM group. This is because the `Finance` PRM group has its own private storage.

Using GlancePlus to analyze your configuration

The following steps guide you in using GlancePlus to determine adjustments you may wish to make to your configuration. GlancePlus has both a text interface (`glance`) and an X-Windows interface (`gpm`).

Having PRM configured but not enabled allows you to track resource use by PRM group through GlancePlus without having PRM actually control the use of these resources. GlancePlus allows you to monitor CPU, memory, and disk bandwidth resource usage.

NOTE GlancePlus does not correctly track the `PRM ID` at the process level for HP-UX 11i v1 and later in versions C.02.65.00 through C.03.25.00. For correct metrics reporting for FSS PRM groups, use GlancePlus Version C.03.35.00.

Also, GlancePlus returns incorrect data for the `PRM_SYS` group for PRM configurations with processor sets defined. Use the `prmmonitor` command instead of GlancePlus if you are using PSET PRM groups.

Step 1. Load the PRM configuration you want to analyze with `prmconfig -ie APPL` if it is not already loaded. This allows you to view the PRM Group List under the Reports menu in GlancePlus.

Step 2. Compare the PRM resource shares against the reported usage in GlancePlus during peak activity. Select the PRM Group List under the Reports menu to see the active processes, users, and their resource use. Determine if you need to adjust the shares or move users or processes to different groups.

Step 3. Change your PRM configuration based on your review of the GlancePlus data.

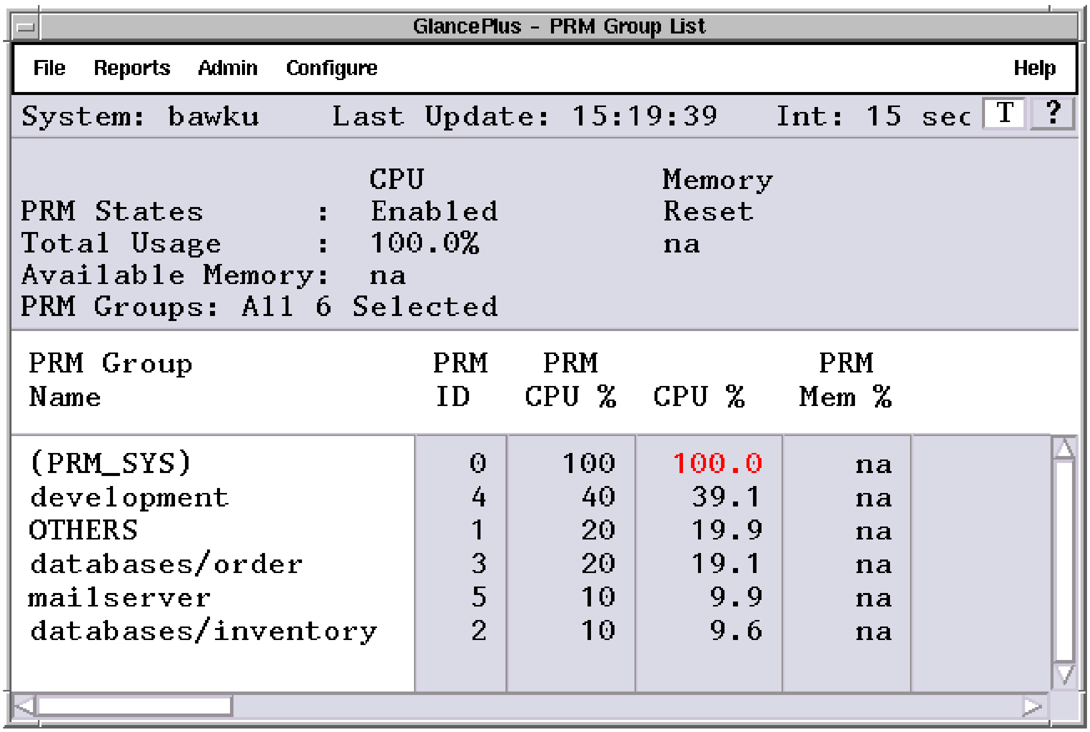
Step 4. Load the changed PRM configuration with `prmconfig -ie APPL`. This load places processes in the owners' initial groups and each configured application in its assigned group.

Step 5. Repeat Step 2, Step 3, and Step 4 as needed.

For information on using GlancePlus, see the GlancePlus online help.

Here is a sample of the GlancePlus information on PRM.

Figure 8-1 GlancePlus information on PRM



Analyzing memory use

The following steps guide you in using PRM's logging facility to examine system memory use.

Step 1. Load a PRM configuration with `prmconfig -ie APPL` if you have not already done so. Do not enable the PRM resource manager at this time. (You can disable PRM with the `prmconfig -d` command if it is already enabled.)

Step 2. Log PRM memory messages by entering:

```
# prmconfig -L MEM
```

Alternatively, you can use the PRM interface in HP System Management Homepage or in HP Systems Insight Manager to enable logging.

Step 3. Check the `/var/adm/syslog/syslog.log` file to determine the percentage of available memory that PRM groups are actually using.

Determine the memory manager's PID:

```
# ps -ef | grep prm2d
```

Then check the file by performing a `grep` on the PID:

```
# tail -f /var/adm/syslog/syslog.log | grep PID_of_current_prm2d
```

Step 4. Adjust memory shares and group assignments in the memory records section of the PRM configuration file based on the information you gather.

Step 5. Load the new PRM configuration with `prmconfig -i` to place processes in the owners' initial groups and each configured application in its assigned group. Re-check the `/var/adm/syslog/syslog.log` file.

Step 6. Repeat Step 3, Step 4, and Step 5 as needed.

Step 7. Turn off memory logging once you are finished examining your processes' memory consumption. Use the following command:

```
# prmconfig -L MEM STOP
```

Alternatively, use the PRM interface in HP System Management Homepage or in HP Systems Insight Manager to turn off logging.

9 Administering PRM

This chapter explains the tasks involved in the daily administration of PRM.

Various PRM commands are mentioned in this chapter. See “Command reference” on page 201 for information on these commands.

Moving processes between PRM groups

This section explains how to move a process from one PRM group to another. You might want to move a process to a different PRM group if it is either not getting enough of or using too much of the resources allocated to its current group.

You can move processes by:

- Process ID
- Process group ID
- User login

To move a process:

Step 1. Use `ps -efP` to get a list of all the processes on the system. This command shows the PRM groups, PIDs, and parents of the processes.

Step 2. Issue the `prmmove` command. The syntax is shown below:

```
prmmove [ targetgrp | -i ][-p PID ... ][-g pgrp ... ][-u
login ... ]
```

targetgrp cannot be a parent in a group hierarchy. When specifying a leaf group, you can use either its PRMID or its group name. For information on hierarchies, see “Hierarchical PRM groups” on page 38.

Consider the following examples:

To move a process with process ID (PID) 100 to the PRM group with PRMID 2:

```
# prmmove 2 -p 100
```

To move the same process to your initial group, use the `-i` option:

```
# prmmove -i -p 100
```

To move multiple processes to your initial group:

```
# prmmove -i -p 100 -p 101 -p 102
```

To move the user’s shell (PID indicated by **$$** below) to PRM group 15:

```
# prmmove 15 -g $$
```

To move all processes owned by `user1` to PRM group `projectX`:

```
# prmmove projectX -u user1
```

NOTE Be careful when using the `-u` option: Configured applications that were invoked by the user (those assigned to a specific PRM group in the configuration file) are moved by this option as well.

This has no effect on subsequent logins of `user1`. To move all of a user’s processes permanently, change the user’s initial group in the configuration file, as discussed in the section “Specifying PRM users” on page 139.

Displaying application filename matches

Because application records allow wildcards in filenames, keeping track of all the applications that a filename with wildcards matches can be difficult.

The `prmlist` command with the `-a` option displays exactly this information, however. It also shows each application's PRM group assignment.

For example, consider a configuration that includes only one application record. This record, shown below, places all applications in /bin/ that begin with the letter "b" in a PRM group named `Bapplications`:

```
/bin/b*::::Bapplications
```

To get a listing of these applications, enter the command:

```
# prmlist -a
```

```
PRM Application                 Assigned Group    Alternate Name(s)
--------------------------------------------------------------------
/bin/bfs                       Bapplications
/bin/bg                        Bapplications
/bin/basename                  Bapplications
/bin/bs                        Bapplications
/bin/bdiff                     Bapplications
/bin/bc                        Bapplications
/bin/banner                    Bapplications
/bin/batch                     Bapplications
/bin/bdf                       Bapplications
```

Displaying netgroup expansions

The combination of user records and multiple netgroup records can make determining a user's initial and alternate PRM groups difficult.

The `prmlist` command displays exactly this information. Using the `prmlist -u +`*`netgroup`* option displays the data for only the specified *`netgroup`*.

For example, consider the following /etc/netgroup entries:

```
prime   two three five  # Define the first three
even    zero two four   # netgroups in terms of the
odd     one three five  # following netgroups
zero    (, user0, )
one     (, user1, )
two     (, user2, )
three   (, user3, )
four    (, user4, )
five    (, user5, )
```

Notice in the entries above that `user2`, `user3`, and `user5` appear in multiple netgroups. Now consider the following PRM configuration:

```
OTHERS:1:20::
even_PRM_group:2:25::
odd_PRM_group:3:25::
prime_PRM_group:4:25::
Five:5:5::

root::::PRM_SYS
guest::::OTHERS
user5::::Five
+even::::even_PRM_group
+odd::::odd_PRM_group
+prime::::prime_PRM_group
```

The configuration places members of the `even` netgroup in the PRM group `even_PRM_group`. Similarly, members of the `odd` and `prime` netgroups are assigned to the PRM groups `odd_PRM_group` and `prime_PRM_group`, respectively. The explicit user record for `user5` assigns that user to the PRM group `Five`.

Using the prmlist command, we get all the group and alternate group assignments (a portion of the output has been omitted for brevity):

```
# prmlist

PRM User                        Initial Group    Alternate Group(s)
-------------------------------------------------------------------
guest                           OTHERS
user0                           even_PRM_group
user1                           odd_PRM_group
user2                           even_PRM_group   prime_PRM_group
user3                           odd_PRM_group    prime_PRM_group
user4                           even_PRM_group
user5                           Five
root                            PRM_SYS
```

For the users who are members of multiple netgroups, their initial and alternate groups are cumulative. For example, user2 is in the even and prime netgroups, with initial groups even_PRM_group and prime_PRM_group, respectively. In this situation, the netgroup names are sorted (based on the ASCII dictionary), and the netgroup at the top of the sort list is used to determine user2's initial PRM group. Thus, because even_PRM_group comes before prime_PRM_group, even_PRM_group is used as the initial group. All other PRM groups specified in the netgroups' user records become alternate groups.

Here the -u option limits the output to the prime netgroup:

```
# prmlist -u +prime

PRM User                        Initial Group    Alternate Group(s)
-------------------------------------------------------------------
user5                           Five
user3                           odd_PRM_group    prime_PRM_group
user2                           even_PRM_group   prime_PRM_group
```

Recall that user5 is in multiple netgroups. Based on the cumulative effect of netgroup membership for user2 and user3, one would expect user5 to show an initial group and at least one alternate group. However, user5 has an explicit user record, which takes precedence over any netgroup's user records.

Displaying accessible PRM groups

Use the `prmmove` command or the `prmrun` command with no options to display the PRM groups you can access. As root, you have access to all PRM groups. Thus, as root, these commands list all configured PRM groups.

Displaying state and configuration information

To print current configuration, state, and mode information, use the command:

`#` **`prmconfig`**

```
PRM configured from file:  /etc/prmconf
File last modified:        Sun Aug 15 11:59:50 1999

PRM CPU scheduler state:  Enabled

PRM Group          PRMID       CPU Entitlement
-----------------------------------------------
GroupA                 2                55.00%
GroupB                 3                15.00%
OTHERS                 1                30.00%

PRM memory manager state:  Enabled  (polling interval: 10 seconds)

PRM User                       Initial Group    Alternate Group(s)
------------------------------------------------------------------
root                           PRM_SYS

PRM application manager state:  Disabled

Disk manager state:  Disabled
```

For more information on `prmconfig`, see the section “`prmconfig`” on page 210.

Displaying application and configuration information

To display information from the current PRM configuration file, including application record information, use the `prmlist` command. This command does not display state information.

```
# prmlist
```

```
PRM configured from file:  /etc/prmconf
File last modified:        Sun Aug 15 12:11:34 1999

PRM Group            PRMID        CPU Entitlement
-----------------------------------------------
GroupA                   2                 55.00%
GroupB                   3                 15.00%
OTHERS                   1                 30.00%

PRM User                        Initial Group    Alternate Group(s)
-------------------------------------------------------------------
root                            PRM_SYS

PRM Application                 Assigned Group    Alternate Name(s)
--------------------------------------------------------------------
/bin/sh                         OTHERS
/usr/bin/man                    GroupB            catman
```

For more information on `prmlist`, see the section "`prmlist`" on page 217.

Setting the memory manager's polling interval

The memory manager examines the use of memory on a regular basis to ensure PRM groups are using memory as specified in the configuration. You can change the frequency of these examinations by changing the polling interval of the manager.

The default polling interval for the memory manager is 10 seconds.

Change the interval on the command line as explained in the following section. You can also change the interval in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Setting the interval with `prmconfig`

To manually change the length of the polling interval, enter the following command, substituting a numerical value for *interval_in_seconds*:

```
# prmconfig -I interval_in_seconds MEM
```

Setting the application manager's polling interval

The application manager regularly examines all processes on the system to ensure applications are running in the correct PRM groups. You can change the frequency of these examinations by changing the polling interval of the manager.

The default polling interval for the application manager is 30 seconds.

Change the interval on the command line as explained in the following section. You can also change the interval in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Setting the interval with `prmconfig`

To manually change the length of the polling interval, enter the following command, substituting a numerical value for *interval_in_seconds*:

```
# prmconfig -I interval_in_seconds APPL
```

Disabling PRM

Disabling PRM does not change the PRM configuration—it only returns control to standard HP-UX resource management. In other words, processes are still assigned a PRMID, but only the standard HP-UX resource management determines what resources processes receive. Having PRM configured but disabled allows you to track resource use by PRM group through `prmanalyze`, GlancePlus, or `acctcom` without having PRM actually control the use of these resources.

Disabling PRM differs from resetting PRM in that:

- PRM daemons remain running
- Processes are tagged with the PRMIDs of their associated groups

To disable PRM on the command line and return to standard HP-UX resource management, see the following section. You can also disable PRM in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Disabling PRM with `prmconfig`

Disable PRM manually by entering the following command:

```
# prmconfig -d
```

Each resource manager can be disabled independently using the `-d` option followed by `APPL`, `CPU`, `DISK`, or `MEM`.

Resetting PRM

When you reset PRM, it returns to its initial state. This is the state PRM is in after it is installed and after the system is booted. Only the standard HP-UX resource management is in effect.

Reset PRM:

- Before shutting your system down (this saves a backup copy of your current configuration).
- Before installing a new version of PRM
- If PRM daemons crash or are killed
- If memory locks or internal shared memory structures fail

Resetting PRM differs from disabling PRM in that:

- PRM daemons are stopped
- Processes are no longer tagged with the PRMIDs of their associated groups

To reset PRM on the command line, erasing your current configuration and disabling PRM, see the following section. You can also reset PRM in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Resetting PRM with `prmconfig`

Reset and stop PRM manually by entering the following command:

```
# prmconfig -r
```

Monitoring PRM groups

To monitor and verify your PRM configuration, use the prmanalyze, prmconfig, prmlist, prmmonitor, id, acctcom, or ps commands or the GlancePlus product.

Sample prmmonitor output is shown below:

```
Tue Mar 21 14:36:42 2000    Sample:  5 seconds
CPU scheduler state:  Enabled
                                                      CPU       CPU
PRM Group                       PRMID   Entitlement      Used
____________________________________________________________
OTHERS                              1        20.00%    20.08%
databases/inventory                 2        10.00%    10.04%
databases/order                     3        20.00%    19.88%
development                         4        40.00%    39.96%
mailserver                          5        10.00%    10.04%

PRM application manager state:  Enabled  (polling interval: 30 seconds)
```

Logging PRM memory messages

You can log PRM memory messages to a file. These messages contain information similar to that of the prmmonitor command. Logging generates messages for every polling interval and can consume a large amount of disk space. For information on changing this interval, see “Setting the memory manager’s polling interval” on page 180.

Messages are logged in the file /var/adm/syslog/syslog.log.

You can control the logging of PRM memory messages on the command line as discussed in the following section. You can also control logging in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Controlling memory logging with `prmconfig`

To begin logging PRM memory messages, enter:

```
# prmconfig -L MEM
```

To stop logging PRM memory messages, enter:

```
# prmconfig -L MEM STOP
```

Logging PRM application messages

The application manager always logs the following to syslog:

- Initial execution interval
- Interval change, if any
- Enabling or disabling of the application manager
- Enabling or disabling of logging

You can enable further logging of applications, of alternate names, and of when and where they are moved. Messages are logged in the file /var/adm/syslog/syslog.log. Logging generates messages for every polling interval. For information on changing this interval, see “Setting the application manager’s polling interval” on page 181.

To enable further logging on the command line, see the following section. You can also control logging in the PRM interface in HP System Management Homepage or in HP Systems Insight Manager.

Controlling application logging with `prmconfig`

To begin logging PRM application messages, enter:

```
# prmconfig -L APPL
```

To stop logging PRM application messages, enter:

```
# prmconfig -L APPL STOP
```

Displaying groups' allocated and used resources

Using the `prmmonitor` command is the primary method to collect data on PRM group activity. With PRM configured and enabled, use `prmmonitor` to print the following information:

- Date
- Time
- Length of sample intervals
- PRM state
- Group names
- PRMID
- Percentages of CPU, memory, and disk bandwidth resources assigned
- Percentage of CPU, memory, and disk bandwidth resources used by each PRM group for the specified interval

NOTE `prmmonitor` displays disk bandwidth information only when you specify a volume group or disk group.

`prmmonitor` also includes some system information such as system name, operating system version, hardware type, and current date.

To display the PRM memory and CPU resource statistics for one 30-second interval, enter the command:

```
# prmmonitor 30 1

Tue Mar 21 15:08:19 2000    Sample:  30 seconds
CPU scheduler state:  Enabled
                                                CPU      CPU
PRM Group                        PRMID   Entitlement     Used
______________________________________________________________
OTHERS                               1        20.00%   20.00%
databases/inventory                  2        10.00%    9.98%
databases/order                      3        20.00%   20.00%
development                          4        40.00%   40.00%
mailserver                           5        10.00%   10.02%

PRM application manager state:  Enabled  (polling interval: 30 seconds)
```

There may be instances when the percentage of a resource used by a specific PRM group differs from the percentage derived from its assigned number of shares for that resource. A group's resource use may be less than it is entitled to when the demand is not there, meaning there are not enough ready processes in that group requesting the resource. On the other hand, a group can consume more of the resource than it is entitled to when other groups in the configuration are not active. The inactive group's resource shares are split up automatically among the active groups.

Displaying user information

The `id` command with the `-P` option prints your PRM group ID (PRMID) in addition to your user ID (UID) and group ID (GID). If the appropriate entry can be found in the internal copy of the configuration file, the `id` command also prints the PRM group name.

```
# id -P
uid=411(user1) gid=200(group1) prmid=3(finance)
```

Displaying available memory to determine number of shares

The prmavail command displays the amount of memory available for user processes when the MEM argument is specified:

```
# prmavail MEM
54300 real memory pages  or 212 MB available (PRM estimate)
```

If prm2d is not running, this value is calculated by subtracting the memory used by the kernel, system processes, and the system paging reserve from total real memory. The available memory decreases if prm2d is running, because PRM reserves 11% of the remaining memory to ensure the processes in PRM_SYS have immediate access to needed memory.

This command is useful in determining memory shares. For example, if a PRM group receives 50 of the 100 memory shares assigned, the number of shares equates to 106 Mbytes on this system. If that is too much or too little memory, the number of shares can be adjusted accordingly.

Displaying number of cores to determine number of shares

The prmavail command displays the number of cores when the CPU argument is specified:

```
# prmavail CPU
16 Cores
```

This command is useful in determining how much CPU resources a number of shares equates to on a multiprocessor system. For example, 25 CPU shares out of a total of 100 shares assigned on a 16-core system is roughly equivalent to 4 cores.

Displaying data on logical volume groups and disk groups

The `prmavail` command displays the names of the logical volume groups (LVM) and disk groups (VxVM) eligible for PRM management when the `DISK` argument is specified:

```
# prmavail DISK

6 volume groups
        /dev/vg00
        /dev/vgcrash
        /dev/vg01
        /dev/vg03
        /dev/vgstripe05
        /dev/vg02
```

This command is useful in determining candidates for disk bandwidth management.

Displaying past process information

The acctcom command with the -P option prints the PRM group name in addition to the customary acctcom information for all groups on the system. Adding the -R option and a PRM group name displays information for that group. The following command displays history information about all PRM groups:

```
# acctcom -P
```

```
COMMAND                        START    END          REAL     CPU
NAME        USER     TTYNAME   TIME     TIME        (SECS)   (SECS)  PRMID
ls          root     ttyp1     17:32:08 17:32:08      0.02     0.01  OTHERS
rm          root     ttyp1     17:32:25 17:32:25      0.25     0.02  OTHERS
registra    root     ?         17:33:04 17:33:04      0.04     0.04  PRM_SYS
vi          dev1     ttyp2     17:33:07 17:33:35     28.20     0.05  develop
cpp.ansi    dev1     ttyp2     17:33:49 17:33:49      0.04     0.01  develop
ccom        dev1     ttyp2     17:33:49 17:33:49      0.16     0.13  develop
ld          dev1     ttyp2     17:33:49 17:33:49      0.15     0.12  develop
cc          dev1     ttyp2     17:33:49 17:33:49      0.41     0.02  develop
vi          dev1     ttyp2     17:34:00 17:34:52     52.57     2.76  develop
hostname    root     ttyp1     17:35:56 17:35:56      0.01     0.01  OTHERS
ls          root     ttyp1     17:36:11 17:36:11      0.03     0.03  OTHERS
more        root     ttyp1     17:36:12 17:36:19      7.00     0.05  OTHERS
```

The prmanalyze utility is also useful for examining past process data. For syntax information, see “prmanalyze” on page 203. For usage examples, see “Using prmanalyze to quickly identify resource use” on page 81 and “Using prmanalyze to analyze your configuration” on page 162.

Displaying current process information

Using the `ps` command with the `-P` option adds a column listing each process's PRM group by name.

```
# ps -P
```

```
   PRMID     PID TTY        TIME COMMAND
 PRM_SYS    1047 ttyp2      0:01 sh
 PRM_SYS    1046 ttyp2      0:02 rlogind
 PRM_SYS    1081 ttyp2      0:00 ps
  OTHERS     548 ?          0:20 sendmail
```

By using `ps` with the `-l` and `-P` options, the PRMID is printed instead of the PRM group name.

```
# ps -l -P
```

```
F S UID PRMID   PID PPID  C PRI NI   ADDR  SZ    WCHAN TTY    TIME COMD
1 S   0     1 3300 3299  0 158 20 65c180  78   418480 ttyp2 0:00 sh
1 R   0     0 3299  492  0 154 20 6a1d80  18          ttyp2 0:00 rlogind
1 R   0     1 3387 3300 15 181 20 662e80  17          ttyp2 0:00 ps
1 S   0     1 4418 4220  4 168 24 821280 982 7ffe6000 ttyp2 0:02 spy
```

The `-R` option, with a PRM group name or PRMID as an argument, displays the `ps` output for the invoker's processes belonging to the specified group.

```
# ps -R OTHERS
```

```
   PID TTY        TIME COMMAND
   588 ?          0:05 sendmail
  4418 ttyp2      0:02 tester
```

Monitoring PRM with GlancePlus

You can use HP's optional performance and monitoring tool GlancePlus to:

- Display PRM reports
- Display resource use in real-time
- Set alarms to report when resource use is excessive

GlancePlus has both a text interface (`glance`) and an X-Windows interface (`gpm`). See the GlancePlus help facility for details.

NOTE GlancePlus does not correctly track the `PRM ID` at the process level for HP-UX 11i v1 and later in versions C.02.65.00 through C.03.25.00. For correct metrics reporting for FSS PRM groups, use GlancePlus Version C.03.35.00 or later.

Also, GlancePlus returns incorrect data for the `PRM_SYS` group for PRM configurations with processor sets defined. Use the `prmmonitor` command instead of GlancePlus if you are using PSET PRM groups.

Monitoring PRM with OpenView Performance Agent (OVPA) / OpenView Performance Manager (OVPM)

You can treat your PRM groups as applications and then track their application metrics in OpenView Performance Agent for UNIX as well as in OpenView Performance Manager for UNIX.

NOTE NOTE: If you complete the procedure below, OVPA/OVPM will track application metrics only for your PRM groups; applications defined in the parm file will no longer be tracked. GlancePlus, however, will still track metrics for both PRM groups and applications defined in your parm file.

To track application metrics for your PRM groups:

1. Edit /var/opt/perf/parm

   Edit your /var/opt/perf/parm file so that the “log” line includes “application=prm” (without the quotes). For example:

```
log global application=prm process dev=disk,lvm transaction
```

2. Restart the agent

   With PRM running, execute the following command:

   `% ` **`mwa restart scope`**

Now all the application metrics will be in terms of PRM groups. That is, your PRM groups will be “applications” for the purposes of tracking metrics.

NOTE The PRM groups must be enabled at the time the scopeux collector is restarted by the `mwa restart scope` command. If PRM is not running, data for some—or all—PRM groups may be absent from OpenView graphs and reports. Also, it may affect alarms defined in /var/opt/perf/alarmdefs.

Automating PRM administration with scripts

To automate PRM administration, you can create scripts that use prmconfig, prmmove, and prmmonitor.

If you want to use prmmonitor to report information that is later manipulated or analyzed by other programs, use prmmonitor -t, directing the output to a logfile; then, create a script that summarizes the output for system accounting.

If you need to change the CPU, memory, or disk bandwidth shares during off hours, say for batch processing, create a script to change the configuration and use cron to run the script. For example, you could use multiple configuration files such as am_prmconf for daytime configuration and pm_prmconf for nighttime configuration.

Protecting the PRM configuration from reboots

To preserve your configuration across boots, modify the variables in the PRM startup script /etc/rc.config.d/prm to automatically configure PRM on reboot. This startup script uses the configuration file you specify or the last active configuration file to configure PRM.

The variables in the /etc/rc.config.d/prm file, along with their default values, are:

```
PRM_CONFIG=0
PRM_CONFIG_FILE=/etc/prmconf
PRM_ENABLE=0
PRM_SLEEP=0
PRM_CAPPING=0
PRM_INT_APPL=0
PRM_INT_MEM=0
PRM_LOG_APPL=0
PRM_LOG_MEM=0
PRM_SNMPAGT=0
```

To configure PRM on reboot, set `PRM_CONFIG` equal to one:

```
PRM_CONFIG=1
```

To use a configuration file other than /etc/prmconf, set `PRM_CONFIG_FILE` equal to the name of the new file:

```
PRM_CONFIG_FILE=/etc/opt/prm/conf/dayconf.prm
```

To enable the appropriate resource managers after PRM has been configured, set `PRM_ENABLE` to one:

```
PRM_ENABLE=1
```

The `PRM_ENABLE` variable can be set to one only when `PRM_CONFIG` is set to one.

To specify a sleep period for PRM, allowing PRM daemons to stabilize when large memory consumers are started immediately after PRM is configured, set `PRM_SLEEP` to the number of seconds to sleep:

PRM_SLEEP=*n*

The `PRM_SLEEP` variable can be set only when `PRM_CONFIG` is set to one.

To enable PRM's `CPUCAPON` mode, set the `PRM_CAPPING` variable equal to one:

```
PRM_CAPPING=1
```

The `PRM_CAPPING` variable can be set to one only when `PRM_ENABLE` is set to one.

To set the interval for the application manager, set `PRM_INTL_APPL` to the number of seconds you want the interval to last:

PRM_INTL_APPL=*seconds*

To set the interval for the memory manager, set `PRM_INTL_MEM` to the number of seconds you want the interval to last:

PRM_INTL_MEM=*seconds*

To log application manager messages to /var/adm/syslog/syslog.log, set `PRM_LOG_APPL` to one:

```
PRM_LOG_APPL=1
```

To log memory manager messages to /var/adm/syslog/syslog.log, set `PRM_LOG_MEM` to one:

```
PRM_LOG_MEM=1
```

To start PRM's SNMP agent on reboot, set `PRM_SNMPAGT` to one:

```
PRM_SNMPAGT=1
```

For more information on this agent, see Appendix C.

Reconstructing a configuration file

When PRM is configured, an internal copy of the configuration file is created as /var/opt/prm/PRM.prmconf. If PRM is then reconfigured, this file is renamed /var/opt/prm/PRM.prmconf.old, and a copy of the new configuration is created as /var/opt/prm/PRM.prmconf. If PRM is reset after being configured, the /var/opt/prm/PRM.prmconf file is renamed /var/opt/prm/PRM.prmconf.old.

These internal copies can be used as backups if your configuration file is lost or corrupted. Be aware though that records for applications or users that were not present when the configuration was loaded will not be in the files.

Table 9-1 shows when the various files are available.

Table 9-1 Internal copies of configuration files

State	Files available
Boot-time	None
Load a configuration	/var/opt/prm/PRM.prmconf (current configuration) /var/tmp/PRM.prmconf (configuration kept for legacy purposes)
Load a configuration when a configuration is already present	/var/opt/prm/PRM.prmconf (current configuration) /var/opt/prm/PRM.prmconf.old (previous configuration) /var/tmp/PRM.prmconf (configuration kept for legacy purposes)
Reset PRM	/var/opt/prm/PRM.prmconf.old (previous configuration)

Backup copies of various files are available in /var/opt/prm/.

You may also see the files /var/opt/prm/PRM.prmconf.src and /var/opt/prm/PRM.prmconf.srcinfo if, with a release prior to C.02.01, you have automatically started PRM at boot time through settings in your /etc/rc.config.d/prm file. The PRM.prmconf.src file is used to configure PRM in such cases.

Special case of interest: Client/server connections

NOTE The scenario described in this section applies only when the application manager is not enabled. Prevent this scenario by enabling the manager using the `prmconfig -e` command.

In a client/server configuration, users attaching to a system via a socket connect (bypassing the normal login procedure) all run as the same user (typically, root or other username). Because PRM uses login names to assign users to specific PRM groups, PRM is not able to distinguish between users attaching to the system using socket connections.

Online cell operations

If you want to perform online cell operations, and:

- Your PRM configuration contains memory records

  Stop memory management (`prmconfig -d MEM`), then after the online cell operation has completed, restart memory management (`prmconfig -e MEM`).

- Your PRM configuration uses PSETs

  Reset PRM (`prmconfig -r`), then after the online cell operation has completed, restart PRM management (`prmconfig -ie [-f` *`file`*`]`).

For more information on online cell operations, see parolrad(1M).

Backing up PRM files

If you would like to make a backup of your PRM environment, be sure to back up the following files:

- /etc/prmconf

  The default PRM configuration file

- /etc/opt/prm/conf/*

  The suggested location for additional PRM configurations. Files in this directory should have the owner set to hpsmh.

- /opt/prm/conf/*

  A location previously suggested for additional PRM configurations

- /etc/rc.config.d/prm

  Configuration file used by /sbin/init.d/prm

- /etc/shells and /opt/prm/shells

  Files used by PRM to ensure PRM's application manager can differentiate shell scripts from one another; these files can also help the application manager differentiate Java binaries

- /etc/cmpt/*.rules

  File containing compartment rules configured for the system (This file is actually an HP-UX 11i Security Containment file. If you have created Secure Resource Partitions, you will have a *.rules file on your system, although not necessarily in /etc/cmpt/. The Security Containment feature is available starting with HP-UX 11i v2.)

A Command reference

This chapter provides an overview of the PRM commands. The PRM commands are:

- `prmagt`
- `prmanalyze`
- `prmavail`
- `prmconfig`
- `prminitconfig`
- `prmlist`
- `prmloadconf`
- `prmmonitor`
- `prmmove`
- `prmrecover`
- `prmrun`
- `prmsmhconfig`
- `prm2scomp`
- `scomp2prm`
- `srpgen`

prmagt

Syntax:

`prmagt -V`

`prmagt [-plock | -stop | -interval` *`seconds`*`]`

Availability: Only a root user can run the `prmagt` command.

The `prmagt` utility is the PRM SNMP read-only agent. It enables SNMP-aware products to collect PRM configuration and usage statistics. Information is updated once per minute or whenever a major configuration change occurs.

NOTE Secure sites may want to disable `prmagt` to avoid unwanted information exchange. If `prmagt` is to be used, it is strongly recommended that it be used only on a trusted internal network protected by firewalls and access controls, due to known issues with the SNMP protocol.

For a listing of the types of information available and an overview of how to access this information, see "Monitoring PRM through SNMP" on page 233.

Table A-1 describes the available options.

Table A-1 **`prmagt` user options/parameters.**

Option	Description
No options	Starts a new `prmagt` daemon if one is not already running.
`-V`	Displays version information and exits.
`-plock`	Locks the agent into real memory. Use this option only on HP-UX versions prior to 11i. This option is useful when remotely collecting `prmagt` data for real-time indications of system paging. If memory is not locked down, the paging activities will cause significant delays and the monitoring tool will only get time-out messages.
`-stop`	Shuts down the currently running agent (if any).
`-interval` *`seconds`*	Specifies how often to sample CPU and disk bandwidth resource information. The *`seconds`* value must be an integer between one and `MAXINT`. The default for this interval is 60 seconds. Memory information is sampled every memory manager interval, as set by `prmconfig`. The default for this interval is 30 seconds.

prmanalyze

Syntax:

```
prmanalyze -V
```

```
prmanalyze [-s {auto | uid | gid | command | prmid}] [-f
config_file] [-r {disk | mem | cpu}] [-t {summary | conflict
| hourly | daily | weekly | monthly}] [-p] [-1] [-E]
[-d resource_density][-m minimum_duration]
[-x exclude_key_value] [filename_list]
```

Availability: Any user can run the `prmanalyze` command assuming the user has read permissions on the files in *filename_list*.

You can only use `prmanalyze` if you have collected UNIX accounting data in a file (default /var/adm/pacct) using `accton` *filename*.

The `prmanalyze` utility scans the accounting files for information on the desired resource type (disk, memory, or CPU) and orders the accounting records by the requested sort key (user, UNIX group, command name, or PRMID).

NOTE The accounting files that `prmanalyze` uses only contain information on terminated processes. For information on active processes, use `prmanalyze` with the `-p` option.

Use this utility when creating an initial PRM configuration (as shown in "Using `prmanalyze` to quickly identify resource use" on page 81) and when fine-tuning existing PRM configurations (shown in "Using `prmanalyze` to analyze your configuration" on page 162).

The `prmanalyze` report indicates the total number of accounting records processed at the beginning of the report. There is one record for every process that has terminated since `accton` began routing data to the specified accounting files.

If a process does not use a measurable amount of a given resource, it is filtered out of the data. Consequently, different resource reports can have slightly different record totals.

If you would like to obtain information for billing based on PRM groups, use /usr/sbin/acct/acctcom -P.

Table A-2 shows the prmanalyze options and parameters.

Running prmanalyze without options or parameters is equivalent to entering the following command line:

```
prmanalyze -s command -r cpu -t summary /var/adm/pacct
```

NOTE For memory, the average, peak, and percent KB values should be comparable to those presented by acctcom. However, the memory totals (in KB minutes) for prmanalyze may differ. This is because HP-UX accounting charges memory usage only when a process is actually running and presumes it takes up no memory whatsoever when the process is not using CPU time. This leads to artificially low numbers for PRM purposes. For the sake of resource management, prmanalyze assumes that a process holds its resident memory pages reserved, whether it uses them or not, for the entire wallclock existence of the process. The prmanalyze reports are designed to help you prevent paging in well-behaved PRM groups by isolating and eliminating sources of conflict. This can lead to total values that are somewhat higher than the values given by other tools. Therefore, be cautious when billing based on prmanalyze memory totals.

Table A-2 prmanalyze options/parameters

Option/parameter	Description
-V	Displays version information and exits.

Table A-2 **`prmanalyze` options/parameters (Continued)**

Option/parameter	Description
`-s {auto | uid | gid | command | prmid}`	Specifies how to sort the accounting data. Only one type of sort is allowed at a time. The data can be sorted based on: • Auto (`auto`) • User ID (`uid`) • Group ID (`gid`) • Command name (`command`) (default) • PRMID (`prmid`) Each sort type can be abbreviated using its first letter.
`-f` *`config_file`*	Tells the analysis not to take the PRMID from the accounting file, but to compute it using the rules in the specified configuration file.

`-r {disk | mem | cpu}`
 	
Abbreviated form:
`-r {d | m | c}`
	Specifies the resource to analyze. Only one resource can be analyzed at a time. The resources are:
	• `disk`
	• `mem`
	• `cpu` (default)
	Each report summarizes total, average, and peak resource consumption.
	Each resource type can be abbreviated using its first letter.

Table A-2 **prmanalyze options/parameters (Continued)**

Option/parameter	Description

`-t {summary | conflict | hourly | daily | weekly | monthly}`
 	
Abbreviated form:
`-t {s | c | h | d | w | m}`
	Specifies the report type. Valid report types are:
	
	`summary` (default)
	
	Provides a high-level view of resource use and is a good starting point when creating a new PRM configuration.
	
	See also the `-1` option.
	
	`conflict`
	
	Provides a detailed view of resource use and is good for fine-tuning a PRM configuration.
	
	This report requires a *resource_density* that is set using the `prmanalyze -d` option or defaults to a value specified in the `-d` description.
	
	Whenever resource use exceeds the *resource_density*, a “conflict” occurs. Each conflict is reported separately, with its start time, stop time, peak consumption, and a list of the processes (grouped by sort type) that contributed to the conflict.
	
	This report is generated using averages and assumes that resource consumption rates remain relatively constant over the life of the process.
	
	Granularity of the conflict report is to the minute.
	
	`hourly`
	
	Divides the accounting files into one-hour slices. This report can help you spot common time-based usage patterns where you might use PRM to prevent contention. Partial hours at the end of the accounting files are not reported.
	
	`daily`, `weekly`, `monthly`
	
	These reports provide higher-level views of the same data given in the hourly report. These reports can help you determine peaks, overall trends, and usage patterns.
	
	The weekly and monthly reports are most commonly used for resource planning and billing purposes.
	
	Each report type can be abbreviated using its first letter.

Table A-2 `prmanalyze` options/parameters (Continued)

Option/parameter	Description
`-p`	Requests that available accounting information for all currently running processes be added to the report. This option allows you to get data on server applications that run indefinitely and consequently are not tracked in the accounting files.
`-1`	Removes all values that are less than 1% of the total. This option can be used with any report, but is most often used when generating a summary report (`-t summary`). It makes the report shorter and easier to read. This option is most useful when sorting by command (`-s command`) or when determining the biggest resource consumers. When using this option, values in the `total` column may not sum to 100%.
`-E`	Generates reports using the exponential format ($x.y$E+p, which equates to $x.y$ times 10^p). This option is most useful when generating a monthly report (`-t monthly`) for disk or memory, and the total values or peak values are in the terabyte range.

Table A-2 `prmanalyze` options/parameters (Continued)

Option/parameter	Description
`-d` *`resource_density`*	Specifies the floating-point *`resource_density`* threshold for a report. Use this option with the conflict report or one of the time-based reports (hourly, daily, ...). When used with the time-based reports, this option filters out time intervals with resource usage less than *`resource_density`*. Express the *`resource_density`* values in the units corresponding to the resource being analyzed. disk KB/second (default: 4096 KB/second) mem KB (default: half the memory available for nonroot users) cpu CPU_time/wallclock_time (default: half the number of cores on the machine) The CPU_time value is the amount of CPU time granted to all active processes during a time interval. The wallclock_time value is the amount of time that elapses on a wallclock during the interval. When this option is not specified, `prmanalyze` uses the default density for the resource being analyzed.
`-m` *`minimum_duration`*	Specifies a minimum job duration (in seconds) for inclusion in reports.
`-x` *`exclude_value_key`*	Specifies a value to exclude from all reports. Using this option removes any line in which the *`exclude_value_key`* is an exact match of the string in the first column (`unique id` column) of the reports. This option can be repeated. It is useful in filtering out known or uninteresting data points.

Table A-2 **prmanalyze options/parameters (Continued)**

Option/parameter	Description
filename_list	Specifies a space-separated list of accounting files. You can use regular expressions to specify the filenames. These files can be listed in any order. This parameter defaults to /var/adm/pacct.

prmavail

Syntax:

`prmavail -V`

`prmavail [-p] [-f] [CPU | DISK | MEM]`

Availability: Any user can run the `prmavail` command.

The `prmavail` command displays information about the resources available on the system for you to divide among PRM groups.

The options are:

`-V`	Displays version information and exits.
`-p`	Displays the total number of cores available on the system and the core IDs for each.
`-f`	Displays the features currently available on the system. Use the `-f` option to determine if disk bandwidth, processor sets, compartments, in-kernel memory controls, or per-group CPU capping are available on the system.

Use `prmavail` with no arguments to display information on all resources. To limit the output to a particular resource, specify only the corresponding resource keyword:

`CPU`	Displays the number of cores on the system.

`DISK`	Displays the number of logical volume groups and disk groups on the system, as well as the names of those logical volume groups and disk groups.
`MEM`	Displays an estimate of the amount of real memory available for user processes. If `prm2d` is not running, this value is calculated by subtracting the memory used by the kernel, system processes, and the system paging reserve from total real memory. The available memory decreases if `prm2d` is running because PRM reserves 11% of the remaining memory to ensure the processes in `PRM_SYS` have immediate access to needed memory.

prmconfig

Syntax:

`prmconfig -V`

`prmconfig [-i | -k] [-s | -c] [-f` *configfile*`]`
`[-d | -e [`*manager*`]] [-r] [-u] [-h] [-w] [-p] [-m]`
`[-I` *interval manager*`] [-L` *manager* `[`*logarg*`]] [-M` *mode*`]`

Availability: This command is most useful to root users; however, users can invoke the command with either no options or with the `-s` option.

This is the primary PRM administration command. With it, the PRM administrator loads a configuration, enables and disables the resource managers, and resets PRM. Users can run the command to get state and configuration information.

When used to configure PRM resource managers, this command creates an internal copy of the configuration file. Also, this command validates the configuration file entries before loading the configuration. Optionally, it cross checks for mismatches between the users listed in the configuration file with the list of users on the system as defined in password files accessible by the C function `getpwnam`.

Table A-3 describes the `prmconfig` options available to both users and root users.

Table A-3 **`prmconfig` user options**

Option	Description
No options	Prints current configuration, state, and mode information.
`-V`	Displays version information and exits.
`-s`	Performs cross checks between the users listed in /etc/prmconf or in a specified file with the list of users in password files accessible by the C function `getpwnam`. Also displays warnings about possible problems with other configuration file entries.
`-c`	Performs a subset of the `-s` checks. The difference between the checks being that the `-s` check verifies every user name in the configuration is in the password file and that every user name in the password file is in the configuration. However, the `-c` check only verifies that user names in the configuration are in the password file.

Table A-4 describes the `prmconfig` options that are available only to root users.

Table A-4 **`prmconfig` root user options**

Option	Description
`-i`	Loads the default configuration file /etc/prmconf (or a specified file) and moves all currently running nonroot user processes to their owners' initial groups and configured applications to their assigned groups. This option does not move root processes, unless they are configured applications, in which case it moves them to their assigned groups. This option does not enable PRM.

Table A-4 prmconfig root user options (Continued)

Option	Description
-k	Loads the default configuration file /etc/prmconf (or a specified file), keeping all currently running processes in their current PRM groups. For information on exceptions to this behavior, see Table 7-1 on page 154. This option does not move root processes. It also does not enable PRM.
-f *configfile* {-i | -k | -s | -c}	Specifies a configuration file other than /etc/prmconf. Use -f only when you are using -i, -k, -s, or -c.
-d [*manager*]	Disables PRM. This option followed by the *manager* keyword CPU, DISK, MEM, or APPL disables only the specified manager. When specifying multiple *manager* arguments, precede each argument with -d. Specifying -d without a keyword disables all managers. This command disables PRM so that only the standard HP-UX resource management is in effect.

Table A-4 `prmconfig` root user options (Continued)

Option	Description
`-e` [*manager*]	Enables PRM. This option followed by one of the *manager* keywords below enables only the corresponding manager: • `CPU` • `DISK` • `MEM` • `APPL` When specifying multiple *manager* arguments, precede each argument with `-e`. Specifying `-e` without a keyword enables all managers. This does not change the current configuration. If there are no memory records, the memory manager is not started. However, if there are no application records, the application manager is still started. Also, the disk bandwidth manager starts—if it is explicitly enabled using `-e DISK`—when there are no disk records; this allows you to perform monitoring.
`-r`	Resets PRM to its boot-time state. PRM is disabled and unconfigured for managing CPU, memory, and disk bandwidth resources and for managing applications.
`-u`	Unlocks a PRM configuration file lock. This lock is put in place to prevent multiple parties from changing the PRM configuration simultaneously. Various HP-UX management products can all lock the configuration file. If one of these products is updating the configuration or terminates without releasing the lock, you will receive the following message: `Configuration lock already held by %s.` Use the `-u` option to force the lock to be released.

Table A-4 `prmconfig` root user options (Continued)

Option	Description
`-h`	Includes parent hierarchical groups in output. (For more information on hierarchical groups, see “Hierarchical PRM groups” on page 38.)
`-w`	Prints the PRM group names in wide-column format, exceeding the 30-column default if necessary to avoid clipping any names.
`-p`	Includes the number of cores and their core IDs for PSET PRM groups in the output.
`-m`	Displays whether memory isolation is being used.
`-I` *`interval manager`*	Overrides the default polling interval for the specified PRM manager. *`interval`* is expressed in seconds. Valid *`manager`* names are: `MEM` Memory manager. The default interval is 10 seconds for `MEM`. `APPL` Application manager. The default interval is 30 seconds for `APPL`.
`-L` *`manager`* [*`logarg`*]	Logs PRM messages. Valid *`manager`* names are: `MEM` Logs memory manager messages. `APPL` Logs application manager messages. Messages are written to the file /var/adm/syslog/syslog.log. The *`logarg`* keyword `STOP` stops logging for the specified resource.

Table A-4 prmconfig root user options (Continued)

Option	Description
-M *toggle*	Starts or stops CPU resource capping for all FSS PRM groups in the configuration—based on their shares values. Valid *toggle* names are: CPUCAPON Turns CPU capping on. CPUCAPOFF Turns CPU capping off. For information on per-group CPU capping, see the section “Group/CPU record syntax” on page 105.

prminitconfig

Syntax:

```
prminitconfig [{ -a | -r}] [-h]
```

The `prminitconfig` command configures or unconfigures the PRM GUI to be available in HP Systems Insight Manager (SIM).

Table A-5 describes the available options. Specifying no option is the same as specifying the `-h` option

Table A-5 **`prminitconfig` options/parameters**

Options/parameters	Description
`-a`	Configure the PRM GUI for SIM. You must run `prminitconfig -a` so that you can access PRM's interface in SIM. Run `prminitconfig -a` after SIM is installed. **NOTE:** If you installed HP Virtual Server Environment Management Software A.03.00.00 or later and ran `vseinitconfig -a`, it ran `prminitconfig -a` for you, assuming PRM was already installed. If PRM was not installed when you ran `vseinitconfig -a`, run `vseinitconfig -a` again instead of running `prminitconfig -a` directly. (Be aware that running `vseinitconfig -a` will restart SIM.) PRM's interface in SIM is available by following the links: Optimize -> Process Resource Manager -> Configure PRM Groups
`-r`	Unconfigure the PRM GUI for SIM, removing the Configure PRM Groups link from SIM. This command is run when PRM is removed from the system.
`-h`	Display the usage string.

prmlist

Syntax:

`prmlist -V`

`prmlist [-h] [-w] [-p] [-m] [-g [group]] [-u [user | +netgroup]] [-s [compartment]] [-a [application]] [-d [LogicalVolumeGroup]] [-G [unix_group]]`

Availability: Any user can run the `prmlist` command.

The `prmlist` command displays information from the current PRM configuration file, including PRM group, memory, user, disk, compartment, application, and Unix group record information.

Table A-6 explains the available options.

Table A-6 `prmlist` user options

Option	Description
No options	Lists all the configuration file information.
`-V`	Displays version information and exits.
`-h`	Includes parent hierarchical groups in output. (For more information on hierarchical groups, see "Hierarchical PRM groups" on page 38.)
`-w`	Prints the PRM group names and application paths in wide-column format, exceeding the 30-column default if necessary to avoid clipping any names or paths.
`-p`	Displays the number of cores and core IDs for PSET PRM groups.
`-m`	Displays the MRG fields.

Table A-6 **`prmlist` user options (Continued)**

Option	Description
`-g [ group]`	Displays all PRM group and memory record information. If *group* is specified, displays only information for the requested PRM group. Specify a group by its name or PRMID.
`-u [ user | +netgroup]`	Displays all user record information. If *user* is specified, displays only information for the requested user records. If *+netgroup* is specified, displays all members of the netgroup and their PRM group assignments.
`-s [ compartment]`	Displays all compartment record information. If *compartment* is specified, displays only information for the requested compartment record.
`-a [ application]`	Displays all application record information, including the expansions for application filenames specified by regular expression. If *application* is specified, displays only information for the requested application record. It is not necessary to include the application's full path. Do not use alternate names with this option.

Table A-6 **`prmlist` user options (Continued)**

Option	Description
`-d [ `*`LogicalVolumeGroup`*`]`	Displays all disk record information. If *`LogicalVolumeGroup`* is specified, displays only information for the requested disk record. The device name must be a directory name beginning with `/dev/v` that contains a group of logical volumes (LVM) or disk groups (VxVM).
`-G [`*`unix_group`*`]`	Displays all Unix group record information. If *`unix_group`* is specified, displays only information for the requested Unix group.

prmloadconf

Syntax:

```
prmloadconf -V
```

```
prmloadconf [-f configfile]
```

Availability: Only root users can execute this command.

This command builds or updates a PRM configuration file with the users on the system as defined by /etc/passwd.

The command first checks to see if the configuration file already exists. If the file does not exist, a default file is generated. If the file does exist, the existing file is checked for suitability (such as the presence of the user default group, `OTHERS`). Use the `-f` *`configfile`* option to specify a configuration file other than /etc/prmconf.

Table A-7 shows the `prmloadconf` options.

Table A-7 **`prmloadconf` root user options**

Option	Description
No options	Creates or updates the PRM configuration file /etc/prmconf.
`-V`	Displays version information and exits.
`-f` *`configfile`*	Creates or updates the PRM configuration given by *`configfile`*.

For each nonroot user in /etc/passwd not already in the PRM configuration file, the command appends a PRM user record that uses the placeholder `(NONE)` as the PRM group. The typical PRM placement rules then apply to the processes owned by the given user. (For information on the placement rules, see “Precedence of PRM group assignments” on page 65.)

For information on other changes `prmloadconf` makes, see the prmloadconf(1) manpage.

`prmmonitor`

Syntax:

`prmmonitor -V`

`prmmonitor [`*`resource`*` | STOPPED] [-h] [-w] [-t] [-s] [`*`interval`*` [`*`iterations`*`]]`

Availability: Any user can run the `prmmonitor` command.

The `prmmonitor` command displays statistics calculated over specified intervals. Use this command to show the percentage of CPU, memory, and disk bandwidth allocated to, and used by, PRM groups. By default, `prmmonitor` prints one iteration of CPU and memory resource information after a one-second wait. It also lists the name and timestamp of the configuration file.

Table A-8 shows the available options.

Table A-8 **`prmmonitor` user options/parameters**

Option/ parameter	Description
No options	Displays allocation and actual use of CPU and memory resources by PRM group.
`-V`	Displays version information and exits.
`resource`	Specifies the resource for which statistics are displayed. Valid *`resource`* keywords are: • `CPU` • `MEM` • `MRG` (providing additional memory resource information for kernels with in-kernel memory controls) • `/dev/vxxx` (where *xxx* completes the name of a valid logical volume group or disk group) If a resource is not specified, statistics are displayed for CPU and memory resources—disk bandwidth resource statistics are not displayed due to the potential for excessive output.
`STOPPED`	Displays `ps`-like output for all processes stopped by the memory manager.
`-h`	Includes parent hierarchical groups in output. (For more information on hierarchical groups, see “Hierarchical PRM groups” on page 38.)
`-w`	Prints the PRM group names in wide-column format, exceeding the 30-column default if necessary to avoid clipping any names.
`-t`	Lists the statistics without table headers.
`-s`	Starts output at PRMID 0 instead of 1.

Table A-8 **prmmonitor user options/parameters (Continued)**

Option/ parameter	Description
interval	Specifies the length in seconds of the sample interval. The HP-UX memory manager typically samples memory data every 10 seconds, so if you specify an interval value less than 10 seconds, the same memory statistics may be repeated in sequential displays.
iterations	Specifies the number of samples to take; if *iterations* is not specified, prmmonitor continues until terminated with a **CTRL-C**.

Differences in output from prmmonitor and top

The prmmonitor output shows the MRG for a process, while the top output shows the PRM group for the process. Typically, the MRG and PRM group for a process match. However, the values may differ temporarily when a process is first moved to a new PRM group.

prmmove

Syntax:

prmmove -V

prmmove [-w]

prmmove [*targetgrp* | -i][-p *PID* ...][-g *pgid* ...]
[-u *login* ...]

Availability: Any user can run the prmmove command.

The prmmove command lets you dynamically move one or more processes between PRM groups. It also lists the process groups you can access.

Processes to be moved can be specified by process ID, process group ID, or user login name.

Root users can use `prmmove` to dynamically change the PRM group of one or more processes to any PRM group.

Users can move processes they own to PRM groups listed in their PRM user records in the configuration file.

You can specify the `-p` option, `-g` option, and `-u` option with multiple arguments in a single use of the `prmmove` command.

Any user can run the `prmmove` command. However, a user must have permission to use the target PRM group and own the process to be moved. Root users have no restrictions. Table A-9 explains the available options.

Table A-9 **`prmmove` user options/parameters**

Option/ parameter	Description
No options	Lists the PRM groups the invoker can access. The first group in the list is the invoking user's initial group.
`-V`	Displays version information and exits.
`-w`	Prints a list of the PRM groups the invoking user can access in wide-column format, exceeding the 30-column default if necessary to avoid clipping any names. The first group in the list is the invoking user's initial group. (Although this option is still supported, you do not need to specify it as its behavior is now the default.)
`targetgrp`	Specifies the target PRM group. Specify a target PRM group by the PRM group name or the PRM group ID (PRMID). *`targetgrp`* cannot be a parent in a hierarchy. For information on hierarchies, see "Hierarchical PRM groups" on page 38.
`-i`	Designates the invoking user's initial group as the target group; or, if `-u` *`login`* is specified, designates the initial group for *`login`* as the target group.

Table A-9 **prmmove user options/parameters (Continued)**

Option/ parameter	Description
`-p` *PID*	Specifies the processes to move by PID. Can take multiple *PID* arguments.
`-g` *pgid*	Specifies the processes to move by process group ID. Can take multiple *pgid* arguments. For information on determining process group IDs, see the prmmove(1M) manpage.
`-u` *login*	Specifies the processes to move by user login name. Can take multiple *login* arguments.

prmrecover

Syntax:

`prmrecover -V`

`prmrecover resource`

Availability: The `prmrecover` command should be run by a superuser.

Use this command to clean up processes after abnormal termination of the memory resource manager.

Table A-10 describes the available options.

Table A-10 **prmrecover user options/parameters**

Option/parameter	Description
`-V`	Displays version information and exits.
`MEM`	Cleans up processes after abnormal memory manager termination.

prmrun

Syntax:

`prmrun -V`

`prmrun [-w]`

`prmrun [-g` *`targetgrp`* `| -i ] [`*`application`* `[`*`arguments`*`]]`

Availability: Any user can run the `prmrun` command. The user must also have permission to execute the application.

The `prmrun` command launches a designated application in a PRM group.

Table A-11 describes the available options.

Table A-11 `prmrun` user options/parameters

Option/parameter	Description
No options	Lists the PRM groups the invoker can access. The first group in the list is the invoking user's initial group.
`-V`	Displays version information and exits.
`-w`	Prints a list of the PRM groups the invoking user can access in wide-column format, exceeding the 30-column default if necessary to avoid clipping any names. The first group in the list is the invoking user's initial group. (Although this option is still supported, you do not need to specify it as its behavior is now the default.)
`-g` *`targetgrp`*	Launches an application in the specified *`targetgrp`*. Use this option when the application is not assigned to the *`targetgrp`* in the PRM configuration file. Checks are performed to see if the *`targetgrp`* appears in the user's list of accessible groups in the configuration file. *`targetgrp`* cannot be a parent in a group hierarchy. For information on hierarchies, see "Hierarchical PRM groups" on page 38.

Table A-11 `prmrun` user options/parameters (Continued)

Option/parameter	Description
`-i`	Launches an application in the user's initial group. Any user can launch an application in the user's initial group using the `-i` option, as long as the user has permission to execute the application.
`application` `[`*`arguments`*`]`	Launches *`application`*, with any specified arguments, in its assigned group, unless `-g` *`targetgrp`* or `-i` is specified.

prmsmhconfig

Syntax:

`prmsmhconfig [{ -c | -u}] [-h]`

The `prmsmhconfig` command configures or unconfigures the PRM GUI to be available in HP System Management Homepage (SMH).

Table A-12 describes the available options. Specifying no option is the same as specifying the `-h` option

Table A-12 `prmsmhconfig` options/parameters

Options/parameters	Description
`-c`	Configure the PRM GUI for SMH. You must run `prmsmhconfig -c` so that you can access PRM's interface in SMH. **NOTE:** Run `prmsmhconfig -c` after SMH is installed. PRM's interface in SMH is available by following the links: Tools -> Resource Management -> Manage PRM Groups

Table A-12 `prmsmhconfig` options/parameters (Continued)

Options/parameters	Description
`-u`	Unconfigure the PRM GUI for SMH, removing the Manage PRM Groups link from SMH. This command is run when PRM is removed from the system.
`-h`	Display the usage string.

prm2scomp

Syntax:

`prm2scomp -p` *`prmpath`* `-s` *`scomppath`* `[-i]`

The `prm2scomp` command generates a minimal configuration for the HP-UX feature Security Containment—based on a PRM configuration.

Table A-13 describes the available options.

Table A-13 `prm2scomp` options/parameters

Option/parameter	Description
`-p` *`prmpath`*	Uses the PRM configuration file specified by *`prmpath`* to generate the Security Containment configuration. `prm2scomp` adds SCOMP records to this file to assign the generated compartments to the PRM groups from which they were generated. *`prmpath`* cannot specify the currently running configuration.

Table A-13 **prm2scomp options/parameters (Continued)**

Option/parameter	Description
`-s` *scmpath*	Saves the generated Security Containment configuration to the file given by *scmpath*. This file must not already exist and cannot be in a directory that is owned by a user other than root or is writable by a user other than owner.
`-i`	Run `prm2scomp` interactively and assign network interfaces to the secure compartments. (Network interfaces are defined in the file /etc/rc.config.d/netconf.) For information on the prompts that `prm2scomp` generates in interactive mode, see the prm2scomp(1) manpage.

scomp2prm

Syntax:

`scomp2prm [-m] -p` *prmpath*

The `scomp2prm` command generates a minimal PRM configuration from a running Security Containment system.

Table A-14 describes the available options.

Table A-14 **scomp2prm options/parameters**

Options/parameters	Description
`-m`	Include memory records for each PRM group in the generated PRM configuration file. Each group's memory allocation is set to the same value.
`-p` *prmpath*	Save the generated PRM configuration to the file given by *prmpath*.

srpgen

Syntax:

`srpgen [-m] -f basepath`

The HP-UX feature Security Containment, available for HP-UX 11i v2 (B.11.23) and later, provides secure compartments. Placing secure compartments inside PRM groups produces Secure Resource Partitions, or SRPs.

`srpgen` generates minimal configuration files for both Security Containment and PRM based on user input. For each SRP name entered, a secure compartment and a PRM group is added to the configuration files.

Table A-15describes the available options.

Table A-15 srpgen options/parameters

Options/parameters	Description
`-m`	Include memory records for each PRM group in the generated PRM configuration file. Each group's memory allocation is set to the same value.
`-f` *`basepath`*	Specifies *`basepath`* as the path and base filename for the generated configuration files. The Security Containment configuration file will be named *`basepath`*.scp. The PRM configuration file will be named *`basepath`*.prm. The *`basepath`*.scp file must not already exist and cannot be in a directory that is owned by a user other than root or is writable by a user other than owner.

`srpgen` is an interactive tool. For information on its prompts, see the srpgen(1) manpage.

B HP-UX command/system call support

Several HP-UX commands and system calls support PRM in assigning users and applications to the proper PRM groups. Other commands have options that allow you to use PRM more efficiently. In either case, this functionality is available only when PRM is configured. See the following tables for information on these commands and system calls.

Table B-1 lists HP-UX commands and system calls that support PRM groups. With HP-UX 11i v1 and later, most HP-UX commands and system calls support PRM.

Table B-1 HP-UX commands/system calls that support PRM groups

Command/ system call	Supports PRM as follows
`at`	Places the scheduled job in the user's initial PRM group. If the user does not have an initial group, the job is placed in the user default group, `OTHERS` (PRMID 1).
`cron`	Places the scheduled job in the user's initial PRM group. If the user does not have an initial group, the job is placed in the user default group, `OTHERS` (PRMID 1).
`login`	Places the login process in the user's initial PRM group. If the user does not have an initial group, the login process is placed in the user default group, `OTHERS` (PRMID 1).
`exec`	Process remains in its current PRM group.
`fork`	Starts children processes in the parent's PRM group.
`pstat`	Returns a process's FSS PRMID.

Table B-2 describes HP-UX commands that have options for PRM.

Table B-2 PRM options in HP-UX commands

Command	Option	Description
`acctcom`	`-P`	Displays the PRMID of each process.
`acctcom`	`-R` *`group`*	Displays only processes belonging to the PRM group given by *`group`*, which is specified by PRM group name or PRMID.
`id`	`-P`	Displays the PRMID and name of the invoking user's initial group.
`ps`	`-P [-l]`	Adds a column named `PRMID` to the `ps` output that gives the PRM group name associated with each process. If you also specify `-l`, you get the PRMID instead of the PRM group name.
`ps`	`-R` *`group_list`*	Displays only the processes that belong to PRM groups specified in *`group_list`*. *`group_list`* must consist of PRMIDs or PRM group names. Groups must be separated by commas; no spaces are allowed.

For more information on these commands, see their manpages.

C Monitoring PRM through SNMP

PRM makes various information available through SNMP. This information can be viewed through products such as HP OpenView Network Node Manager. Reported data includes:

- Resource usage assigned to and achieved by each PRM group
- Manager states
- Time of last PRM configuration

NOTE PRM's SNMP data does not include any information on user records in the PRM configuration.

PRM's data is in the SNMP subtree `hp.hpSysMgt.hpUXSysMgt.hpPRM.prmReadOnly`. This subtree has the numeric SNMP address .1.3.6.1.4.1.11.5.4.2.1.

Table C-1 lists all the components of `prmReadOnly`.

Table C-1 Structure of PRM's SNMP data (`prmReadOnly`)

PRM data		Corresponding SNMP string
Global data		`globalInfo`
	PRM version	`releaseVersion`
	Configuration lock owner	`configLockOwner`
	Name of active configuration file	`configFileName`
	Time of last modification to configuration file	`configFileDate`
CPU resource		`cpuResource`

Table C-1 Structure of PRM's SNMP data (`prmReadOnly`) (Continued)

PRM data		Corresponding SNMP string
Major sequence number*		`cpuSequenceNum`
CPUs available		`cpuAvail`
Manager state		`cpuManagerState`
Sample interval		`cpuInterval`
Capping state		`cpuCapState`
Group count		`cpuGroupCount`
Group/CPU records:		`cpuTable`
	Name	`cpuGroupName`
	PRMID	`cpuPRMid`
	Percent entitled	`cpuPercentEnt`
	Percent of machine received	`cpuPercentGot`
	Shares entitled	`cpuSharesEnt`
	Ticks this interval	`cpuTicksGot`
MEM resource		`memResource`

Table C-1 Structure of PRM's SNMP data (`prmReadOnly`) (Continued)

PRM data		Corresponding SNMP string
Major sequence number*		`memSequenceNum`
MB available		`memAvail`
Manager version		`memManagerVersion`
Manager state		`memManagerState`
Manager interval		`memInterval`
Logging state		`memLoggingState`
Record count		`memGroupCount`
Global paging (Boolean)		`memPagingSeen`
Memory records:		`memTable`
	Name	`memGroupName`
	PRMID	`memPRMid`
	Percent entitled	`memPercentEnt`
	Percent maximum (cap)	`memPercentMax`
	Percent of machine received	`memPercentGot`
	Pages entitled	`memPagesEnt`
	Pages used	`memPagesGot`
	Members	`members`
	Paging count	`mrgPaging`
	Pages locked	`mrgPagesLocked`
DISK resource		`diskResource`

Table C-1 Structure of PRM's SNMP data (`prmReadOnly`) (Continued)

	PRM data		Corresponding SNMP string
	Major sequence number *		`diskSequenceNum`
	Manager state		`diskManagerState`
	Sample interval		`diskInterval`
	Device count		`diskDeviceCount`
	Group count		`diskGroupCount`
	Devices:		`diskTable`
		Device name	`diskDeviceName`
		Group name	`diskGroupName`
		PRMID	`diskPRMid`
		Percent entitled	`diskPercentEnt`
		Percent of machine received	`diskPercentGot`
		Shares entitled	`diskSharesEnt`
		Bytes received	`diskKBytesGot`
APPL manager			`applResource`
	Manager state		`applManagerState`
	Manager interval		`applInterval`
	Logging state		`applLoggingState`
	Record count		`applGroupCount`
	Application records:		`applTable`
		Path	`applPathName`
		Group name	`applGroupName`
		Altname	`applAltName`

*. The major sequence number indicates the number of times a configuration has changed since the last reset.

Accessing PRM's SNMP data

You can access SNMP information through a command-line interface, known as `snmpwalk`, and through a graphical user interface called `xnmbrowser`. Using these utilities is described below.

Using OpenView's `snmpwalk`

NOTE Secure sites may want to disable `prmagt` to avoid unwanted information exchange. If `prmagt` is to be used, it is strongly recommended that it be used only on a trusted internal network protected by firewalls and access controls, due to known issues with the SNMP protocol.

To use `snmpwalk` to view the PRM data:

Step 1. If PRM's SNMP agent is not already running, start it on each system from which you want to view data:

```
# /opt/prm/bin/prmagt
```

If you need to stop the agent, use its `-stop` option.

You can have the agent automatically start at boot by setting the `PRM_SNMPAGT` variable in the file /etc/rc.config.d/prm to 1:

```
PRM_SNMPAGT=1
```

Step 2. Run `snmpwalk`, giving an argument to indicate the desired information. All information from that level and below is reported. Thus, the following command displays all the data listed in Table C-1.

```
# /opt/OV/bin/snmpwalk \
hostname hp.hpSysMgt.hpUXSysMgt.hpPRM.prmReadOnly
```

You can limit the data displayed by choosing a lower level item. For example, to display only information on application records, enter the following command:

```
# /opt/OV/bin/snmpwalk \
hostname hp.hpSysMgt.hpUXSysMgt.hpPRM.prmReadOnly.applResource
```

Using OpenView's xnmbrowser

NOTE Secure sites may want to disable `prmagt` to avoid unwanted information exchange. If `prmagt` is to be used, it is strongly recommended that it be used only on a trusted internal network protected by firewalls and access controls, due to known issues with the SNMP protocol.

To use `xnmbrowser` to view the PRM data:

Step 1. If PRM's SNMP agent is not already running, start it on each system from which you want to view data:

```
# /opt/prm/bin/prmagt
```

If you need to stop the agent, use its `-stop` option.

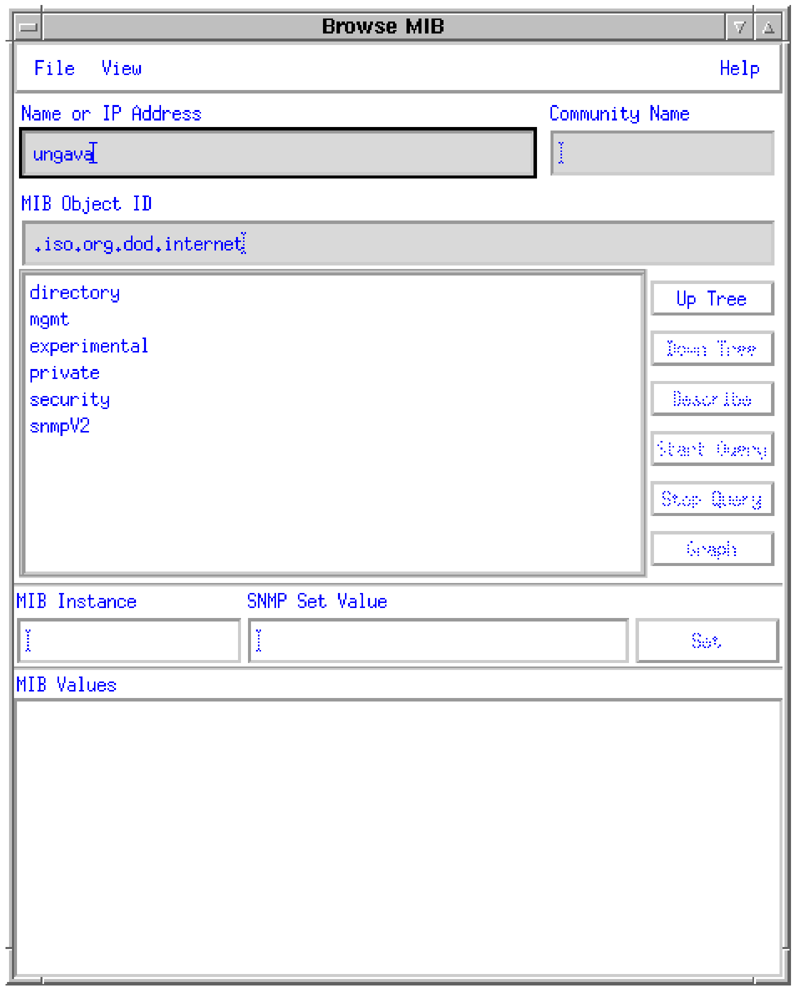
You can have the agent automatically start at boot by setting the `PRM_SNMPAGT` variable in the file /etc/rc.config.d/prm to 1:

```
PRM_SNMPAGT=1
```

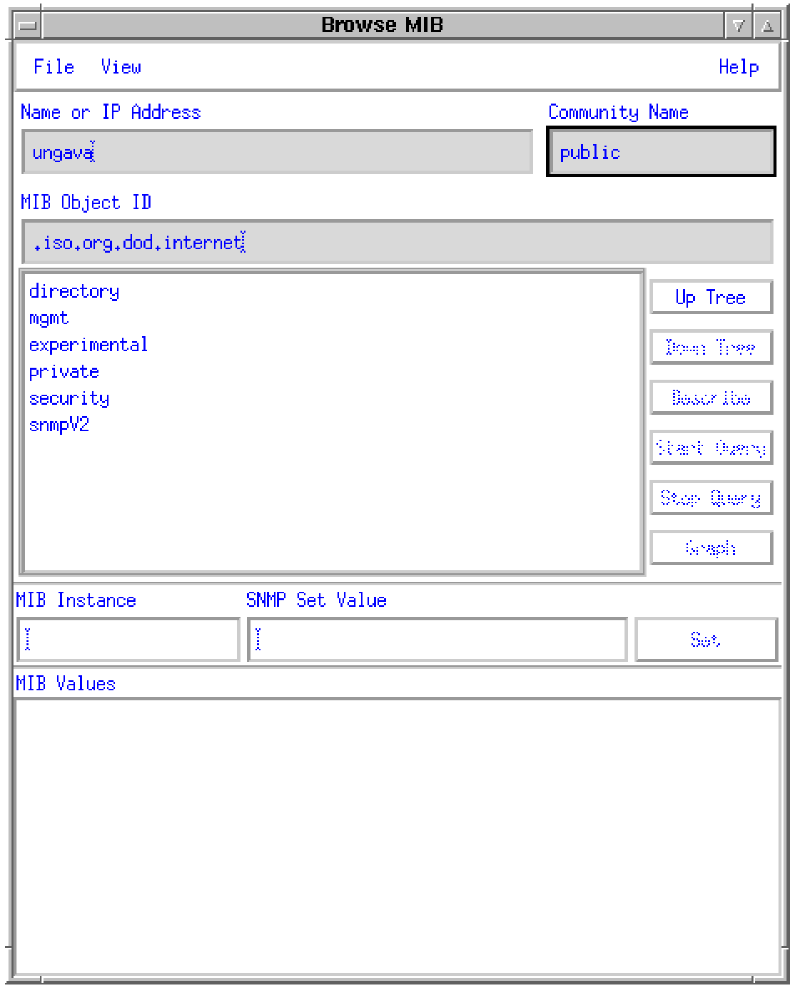
Step 2. Start `xnmbrowsesr`:

```
# /opt/OV/bin/xnmbrowser
```

Step 3. Enter the name of the system to monitor in the field Name or IP Address. In the following graphic, the system name is ungava.



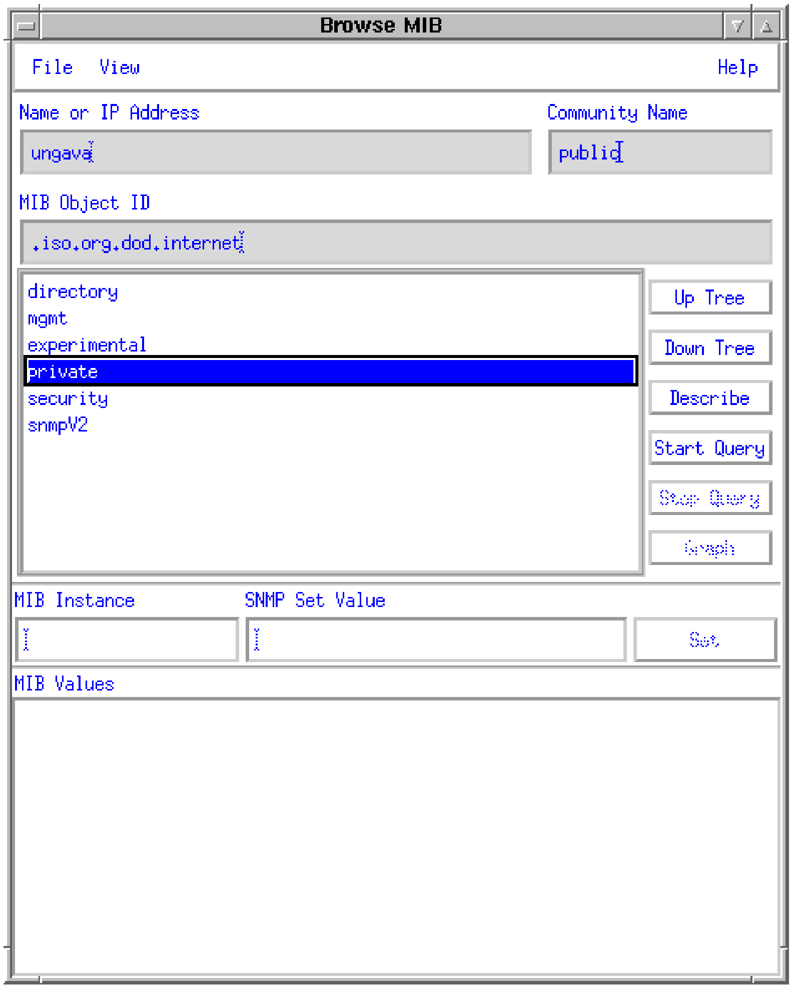
Step 4. Enter “public” in the field Community Name.



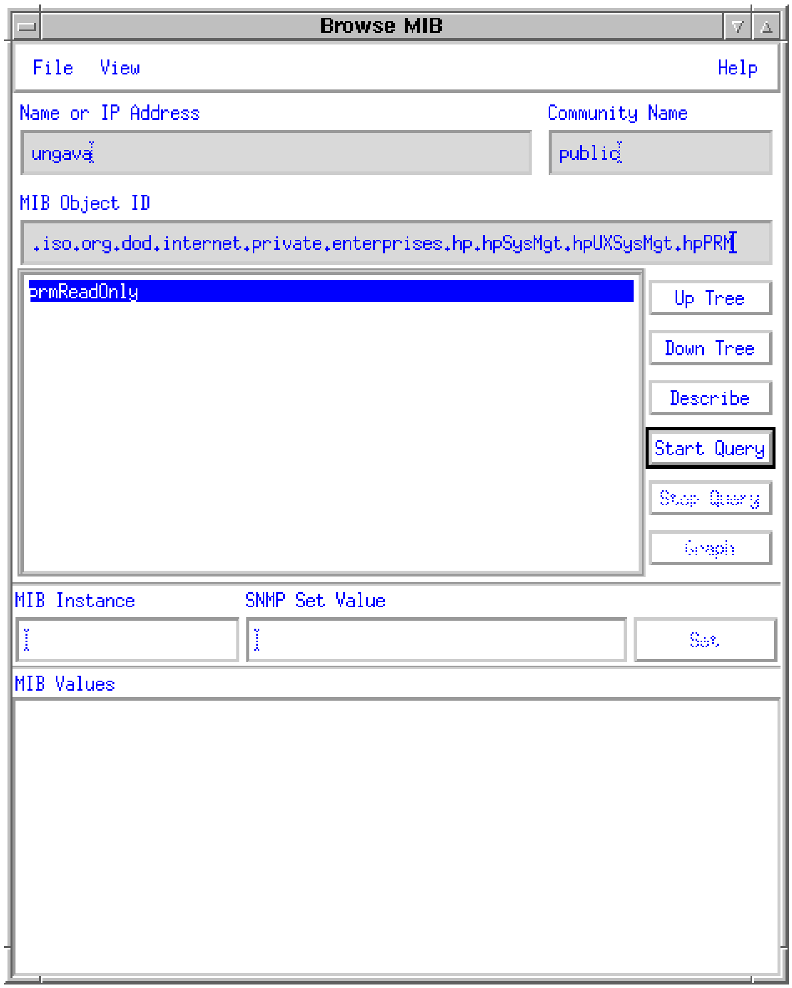
Step 5. Navigate to the PRM’s data by following the hierarchy:

```
private
enterprises
hp
hpSysMgt
hpUXSysMgt
hpPRM
prmReadOnly
```

The graphic below shows the beginning of the hierarchy.



Step 6. Press the Start Query button to get all PRM data or continue navigating deeper to the desired level, then press the Start Query button.



Graphing resource usage

You can use `xnmbrowser` to graph various data.

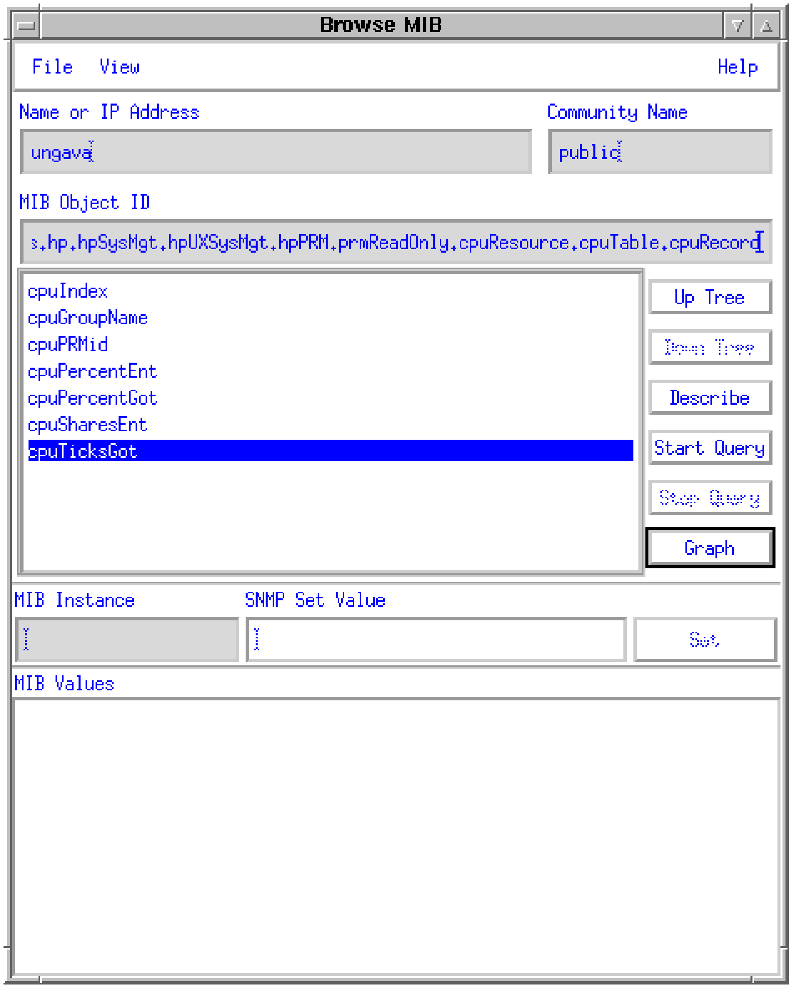
NOTE `xnmbrowser` can only graph integer values. String values cannot be graphed. The `xnmbrowser` utility indicates an item that can be graphed by making the Graph button active, as seen in the following procedure.

To see how many CPU ticks each PRM group is getting:

Step 1. Navigate to `cpuTicksGot` starting from `prmReadOnly`:

```
cpuResource
cpuTable
cpuRecord
cpuTicksGot
```

Step 2. Select the Graph button on the right side of the browser.



A graph similar to the following appears.

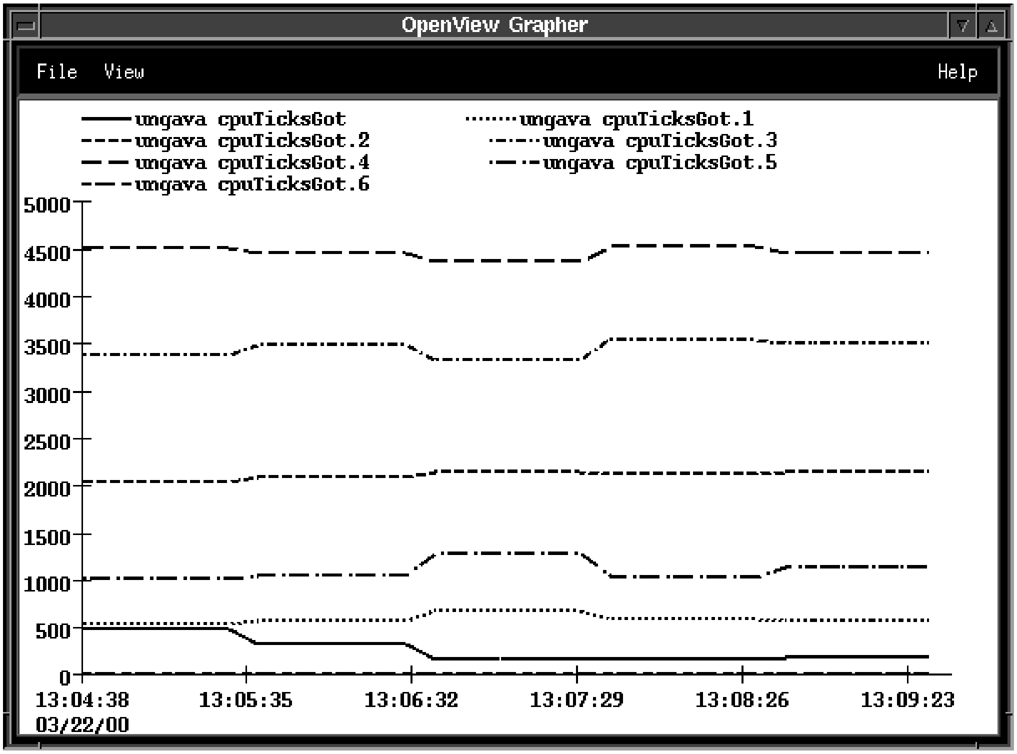

OpenView Grapher
File View Help
ungava cpuTicksGot
ungava cpuTicksGot.1
ungava cpuTicksGot.2
ungava cpuTicksGot.3
ungava cpuTicksGot.4
ungava cpuTicksGot.5
ungava cpuTicksGot.6
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
13:04:38
03/22/00
13:05:35
13:06:32
13:07:29
13:08:26
13:09:23

Table C-2 maps the PRM groups to their respective identifiers in the graph. Note how each group's PRMID is used in its `cpuTicksGot` identifier. The `development` group comes in with approximately 4500 ticks. The `databases/order` group converges on 3500 ticks, while `databases/inventory` and `mailserver` come in at about 2000 and 1000 ticks, respectively. `OTHERS` and `PRM_SYS` get the fewest ticks. The amount of idle CPU, represented by `cpuTicksGot.6`, stays constant at 0.

Table C-2 PRM groups in `xnmbrowser` graph

PRM group	PRMID	Identifier on graph
`PRM_SYS`	0	cputTicksGot
`OTHERS`	1	cputTicksGot.1
`databases/inventory`	2	cputTicksGot.2
`databases/order`	3	cputTicksGot.3
`development`	4	cputTicksGot.4
`mailserver`	5	cputTicksGot.5
Idle (not a group—remaining CPU)	N/A	cputTicksGot.6

D Creating Secure Resource Partitions

The optional HP-UX feature Security Containment, available starting with HP-UX 11i v2 (B.11.23), provides “secure compartments,” which allow you to isolate processes and files. You can place one or more secure compartments in a single PRM group to manage the resource allocation for your secure compartments.

Using these features together, you form Secure Resource Partitions.

You can assign compartments to PRM groups to form Secure Resource Partitions using either the PRM configuration file or the PRM GUI. For more information, see “Specifying PRM groups/controlling CPU resource use” on page 104.

PRM also provides the following utilities for use with Security Containment:

`prm2scomp` Generates a minimal Security Containment configuration from a PRM configuration.

`scomp2prm` Generates a minimal PRM configuration from a Security Containment configuration.

`srpgen` Generates Secure Resource Partitions by creating both a minimal Security Containment configuration and a minimal PRM configuration based on your input.

E Using PRM with Serviceguard

The optional HP product Serviceguard provides users and applications with a high availability environment. Serviceguard makes this environment possible by moving applications from one server to another when the original server or application session is unable to complete the desired jobs. You can set up PRM to control applications on the primary server and on a secondary server in the event of a failover. Such a set up requires a Serviceguard package control script that consists of the applications that PRM controls and a customer-defined function to control PRM.

Specify applications that PRM should control using the `SERVICE_CMD[]` variable in the package control script. When specifying an application, be sure to launch the application under PRM control using the `prmrun` command. For example, the following line launches *`application`* in the PRM group `math_dept`.

```
SERVICE_CMD[0]="/opt/prm/bin/prmrun -g math_dept
application"
```

NOTE If application records in your PRM configuration reference executable files that are unavailable due to being on a filesystem that is part of a Serviceguard package that is not available, PRM ignores the application records. Reload the PRM configuration with `prmconfig` when the filesystem is present for the application records to take effect. To automate the reload, you could place the `prmconfig` command toward the end of the Serviceguard package script.

An example of a customer-defined function is given on the following pages. It performs the following tasks:

1. Checks to see if PRM is installed.
2. If PRM is installed, it checks for the desired configuration file.
3. If the desired configuration file is not found, it is created.
4. Checks to see if PRM is configured.
5. If PRM is not already configured, the desired configuration is loaded.
6. If PRM is already configured, the configuration is checked for the group `math_dept`. This is the group the application should run in. If `math_dept` is not found, a warning is issued. Because `math_dept` is not available, the Serviceguard package will be started in the PRM group it is assigned in the PRM configuration.
7. If the `math_dept` group exists already, the configuration is logged for future reference. The Serviceguard package will run in the `math_dept` group.

Here is the example control function:

```
# START OF CUSTOMER DEFINED FUNCTIONS

function customer_defined_run_cmds
{
    # customer defined run commands.

    UNAME=`uname -n`

    # check to make sure prm is installed

    if [ -f /opt/prm/bin/prmconfig ]
    then
        # check that our prm config file is there; if not, create it

        if [ ! -f /etc/opt/prm/conf/Serviceguard ]
        then
            cat > /etc/opt/prm/conf/Serviceguard << EOF1
#
# sample Serviceguard PRM config file for a university
#

# groups
OTHERS:1:10::
math_dept:2:40::
computer_dept:3:50::

# users
root::::PRM_SYS

# application records
/opt/math/bin/tool:::math_dept,num_cruncher,print_answer
/usr/local/games/tetris::::computer_dept
EOF1
        fi

        # is PRM turned on?

        /opt/prm/bin/prmconfig 2> /dev/null > /dev/null
        if [ “$?” -eq “1” ]
        then
           # need to initialize PRM

           /opt/prm/bin/prmconfig -ie -f /etc/opt/prm/conf/Serviceguard
           if [ “$?” -eq “1” ]
           then
```

```
            echo "WARNING : prmconfig -f /etc/opt/prm/conf/Serviceguard failed"
            return 0
          fi
      else
          # make sure it has my group

          /opt/prm/bin/prmconfig | grep math_dept > /dev/null 2> /dev/null
          if [ "$?" -ne "0" ]
          then
             echo "WARNING : conflicting PRM already running on $UNAME"
              return 0
          else
              # log the initial configuration

              /opt/prm/bin/prmconfig
          fi
      fi
    else
      # no luck.  PRM not installed

      echo "PRM not installed on $UNAME"
      return 0
    fi

    return 0
}
```

For information on setting up Serviceguard, see the manual *Managing ServiceGuard*.

F Using PRM with HP Integrity Virtual Machines

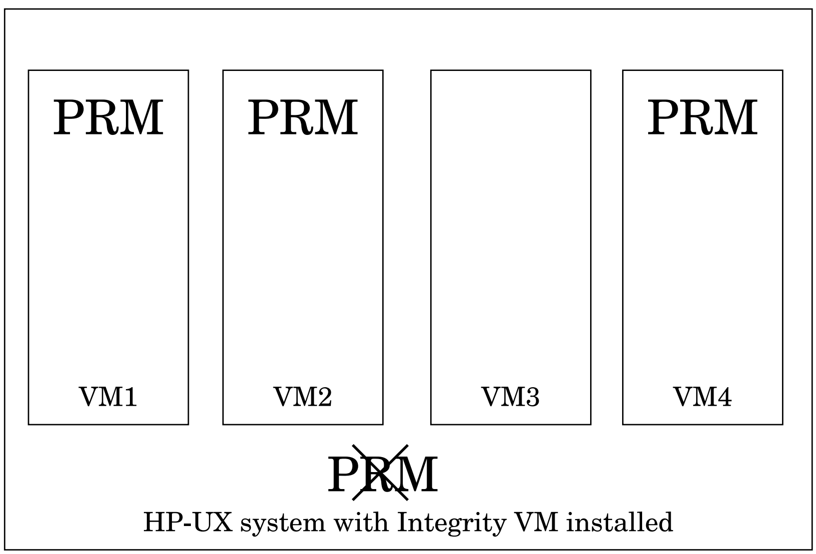
HP Integrity Virtual Machines (Integrity VM) is a robust soft partitioning and virtualization technology that provides operating systems isolation, shared CPU (with sub-CPU granularity), shared I/O, and automatic, dynamic resource allocation. It is available for HP-UX 11i v2 and later running on HP Integrity servers.

Given a system with Integrity VM installed, you can run PRM inside any of the virtual machines; however, you cannot run PRM on the VM host as the `vm_fssagt` already controls FSS groups on behalf of Integrity VM.

NOTE Do not specify disk bandwidth records for configurations used inside virtual machines.

The following figure illustrates where PRM can be used:

Figure F-1 PRM and Virtual Machines



G PRM error messages

This appendix lists all PRM error messages with cause and action text. The messages are grouped by command:

- `prmmonitor`—error messages starting at number 001
- `prmconfig`—error messages starting at number 200
- `prmmove`—error messages starting at number 401
- `prmrun`—error messages starting at number 601
- `prmlist`—error messages starting at number 802
- `prmrecover`—error messages starting at number 1000
- `prmavail`—error messages starting at number 1200
- `prmanalyze`—error messages starting at number 1501
- `prmagt`—error messages starting at number 1601

The error messages in this appendix contain the symbols: `%s` and `%d`. These symbols are placeholders that appear in the actual error messages as file, group, user, command, or application names, or as numbers.

prmmonitor error messages

001

Message	`Interval and number of samples must be more than 0 and less than %d.`
Cause	Command arguments are invalid.
Action	Specify positive integers as command arguments.

002

Message	`PRM is not configured.`
Cause	PRM is not configured; there is nothing to monitor.
Action	Configure and enable PRM (`prmconfig -k -e` or `prmconfig -i -e`) prior to running `prmmonitor`.

003

Message	`PRM resource manager(s) disabled.`
Cause	Requested information for PRM when no managers were active, or requested information for a specific PRM manager that is not active.
Action	Enable PRM (`prmconfig -e`) prior to running `prmmonitor`.

004

Message	`The Resource argument may only be the keywords CPU, MEM, MRG, or <volume_group_name>.`
Cause	The optional Resource argument provided is not a recognized keyword.
Action	Re-enter `prmmonitor` command and use `CPU`, `MEM`, or `MRG` for the resource argument. You can also specify a volume group.

`147`

Message	`PRM Memory Resource Group (MRG) feature not included in this system.`
Cause	In-kernel memory controls are not available on the system.
Action	Do not specify the `MRG` option for this command on systems where in-kernel memory controls are not available.

`150`

Message	`Current Memory manager does not stop jobs.`
Cause	In-kernel memory controls are not available on the system.
Action	Do not specify the `STOPPED` option for this command on systems where in-kernel memory controls are not available.

`173`

Message	`Device name %s not a valid volume group`
Cause	First argument was not a valid volume group name. Either the format does not begin with `/dev/v` or no device of that description exists.
Action	Use the `bdf` command to determine the actual name of the logical volume group.

`178`

Message	`Memory resource statistics unavailable to non-root users.`
Cause	Attempting to view data logged in as a user other than root.
Action	Log in as root to view this data.

`prmconfig` error messages

201

Message `PRM is not included in the system.`

Cause The kernel has not been built with `libprm.a`.

Action Check that PRM is in the system file (/stand/system). Then rebuild the kernel with `/usr/sbin/mk_kernel`.

202

Message `Configuration lock already held by %s.`

Cause Someone is currently configuring PRM.

Action Consult the other party to determine the proper configurations needed for the system.

203

Message `The -r option may not be used with any other option.`

Cause The `-r` option was used with one or more other options.

Action Use the `-r` option by itself or use the other options without specifying `-r`.

204

Message `The -u option may not be used with any other option.`

Cause The `-u` option was used with one or more other options.

Action Use the `-u` option by itself or use the other options without specifying `-u`.

205

Message	`Could not find configuration file.`
Cause	Could not open /etc/prmconf or the specified file for reading.
Action	Make sure configuration file exists and is readable by superusers.

206

Message	`%s: illegal option "%s"`
Cause	An unknown option was specified on the command line.
Action	Check the usage message or the prmconfig(1) manpage for valid options.

207

Message	`%s: -p not valid. Processor sets not available.`
Cause	Processor sets are not available on the system.
Action	Do not specify the `-p` option for this command on systems where processor sets are not available.

208

Message	`%s: -m not valid. In-kernel memory controls not available.`
Cause	In-kernel memory controls are not available on the system.
Action	Do not specify the `-m` option for this command on systems where in-kernel memory controls are not available.

216

Message	`The -s and -c options cannot be used together.`
Cause	`prmconfig` command specified with both `-s` and `-c` options.
Action	Re-enter command, specifying either `-s` or `-c`, not both.

225

Message	`Cannot enable. PRM is not configured.`
Cause	`prmconfig -e` option used before `-k` or `-i` option.
Action	Configure and enable PRM with `prmconfig -ke` or `-ie` options. PRM options are executed in command-line order.

226

Message	`Cannot display configuration. PRM is not configured.`
Cause	`prmconfig` command used without options before PRM is configured.
Action	Configure PRM with `prmconfig -k` or `-i` before requesting PRM configuration and state information.

227

Message	`PRM is disabled and not configured.`
Cause	`prmconfig -d` used before PRM is configured.
Action	No action required because PRM is already disabled.

228

Message	`You must be superuser to use -d, -e, -i, -k, -r, -u, -I, -L. or -M.`
Cause	A user with UID other than zero tried to execute the `prmconfig` command with an option other than `-s` or `-c`.
Action	Nonroot users are only allowed to use `prmconfig` with no options, with the `-s` option, or with the `-c` option.

231

Message `Could not disable PRM %s:` (HP-UX error message)

Cause You are not running as superuser, or an internal system failure.

Action Log in as superuser and try again or take action based on the HP-UX error message. If that does not work, contact system support staff.

232

Message `Could not enable PRM %s:` (HP-UX error message)

Cause You are not running as superuser or an internal system failure.

Action Log in as superuser and try again or take action based on the HP-UX error message. If that does not work, contact system support staff.

233

Message `Warning: Could not back up internal configuration file %s:` (HP-UX error message)

Cause The /var/tmp directory is full or the internal configuration file does not exist.

Action Check the available disk space and `touch` the file /var/tmp/PRM.prmconf.old.

241

Message `Note: no PRM User record for passwd file user %s.`

Cause There is a user in the system password file that does not have a corresponding record in the PRM configuration.

Action Add the user to the PRM configuration.

`244`

Message `The -i and -k options cannot be used together.`

Cause `prmconfig` command specified with both `-i` and `-k` options.

Action Re-enter command, specifying either `-i` or `-k`, not both.

`247`

Message `The -f option requires an argument.`

Cause The filename argument is missing.

Action Enter the command, include the filename argument with the `-f` option.

`248`

Message `Pathname too long.`

Cause The pathname entered as an argument to `-f` exceeds 1024 characters.

Action Verify path is correct.

`249`

Message `Directory path %s not found.`

Cause The pathname entered does not exist.

Action Verify path is correct.

`250`

Message `Disable (-d) and enable (-e) are mutually exclusive. Specify only one on the command line.`

Cause You cannot disable and enable in the same command.

Action Choose either `-d` or `-e`.

`251`

Message `Extra arguments at end of command line.`

Cause You provided more arguments than expected.

Action Check command syntax for correct option usage.

286

Message `Manager arg for prmconfig -d or -e may only be DISK, APPL, CPU or MEM.`

Cause The Manager argument specified for the `prmconfig -d` or `-e` command is not a recognized keyword.

Action Re-enter the command and either disable or enable all of the configured PRM managers or use a valid Manager argument to select the desired PRM manager to disable or enable.

287

Message `Both the Interval and Manager arguments are required for prmconfig -I.`

Cause Both of the required arguments were not entered with the interval option of the `prmconfig` command.

Action Re-enter the command, supplying both the Interval and Manager arguments for the `-I` option. The Interval argument is number of seconds, and the Manager argument is the keyword `MEM` or `APPL`.

288

Message `Manager argument APPL or MEM is required for prmconfig -I or -L.`

Cause The Manager argument for the `prmconfig -I` or `-L` command is either missing or not a recognized keyword.

Action Re-enter the command with a recognized keyword for the Manager argument.

289

Message `The Logarg argument for prmconfig -L may only be the keyword STOP.`

Cause The optional Logarg argument for the `prmconfig -L` command is not a recognized keyword.

Action Re-enter the command and either skip the Logarg argument or enter `STOP` for the Logarg argument.

`291`

Message `The -M option requires a keyword argument.`

Cause The `-M` option was used without an argument.

Action Use either `CPUCAPON` or `CPUCAPOFF` as an argument to `-M`.

`292`

Message `Unrecognized keyword argument for -M option.`

Cause The entered argument to `-M` is not valid.

Action Use either `CPUCAPON` or `CPUCAPOFF` as an argument to `-M`.

`294`

Message `Enabling of CPU cap only allowed when PRM CPU scheduler enabled.`

Cause Attempted to enable `CPUCAPON` mode when the PRM CPU manager is not active.

Action Enable the CPU manager before enabling `CPUCAPON` mode.

`295`

Message `Could not set PRM cap; %s` (HP-UX error message)

Cause The CPU manager is disabled.

Action Ensure the CPU manager is enabled, then attempt to enable `CPUCAPON` mode again.

296

Message `Unable to change the polling interval of the %s manager:` (HP-UX error message)

Cause You are not running as root, the manager is no longer enabled, or an internal system failure.

Action Log in as superuser and try again or check that the manager is running. If it is running, see if using `prmconfig -r` resolves the problem. Be sure to load a configuration and enable the resource manager after resetting PRM. Also, ensure that no other superusers are simultaneously changing the configuration with `prmconfig`, the SMH interface, or the SIM interface. Take action based on the HP-UX error message. If problem persists, contact system support staff.

297

Message `Interval must be an integer more than 0 and less than %d.`

Cause An invalid interval was specified.

Action Check `prmconfig -I` usage.

298

Message `Unable to change logging status of the %s manager.`

Cause Manager is no longer enabled or an internal system failure.

Action Check that the manager is running. If it is running, see if using `prmconfig -r` resolves the problem. Be sure to load a configuration and enable the resource manager after resetting PRM. Also, ensure that no other superusers are simultaneously changing the configuration with `prmconfig`, the SMH interface, or the SIM interface. If problem persists, contact system support staff.

prmmove error messages

`401`

Message `Warning! All root processes with pid > 0 have been moved to group %s.`

Cause Command `prmmove %s -u user1` executed where `user1` is a superuser. This moves all root processes (except PID 0) to a group other than the PRM system group. This includes almost all of the system processes.

Action If this was your intention, then no further action is required. Otherwise, start over by first executing `prmmove 0 -u user1` to move all superuser processes back to the PRM system group. Then move individual processes or process groups to the desired target group with the `prmmove` *`targetgrp`* `-p` *`PID`* or `prmmove` *`targetgrp`* `-g` *`process_group_PID`* syntax.

`402`

Message `%s not a recognized user name.`

Cause The user name `%s` specified on the command line as an argument to the `-u` option is not spelled correctly or is not in a password file, such as /etc/passwd, that is accessible by the C function `getpwnam`.

Action Check the spelling. If the spelling is correct, add the user to the appropriate password file.

`403`

Message `Could not find access list for user %s.`

Cause Cannot find PRM user record for `%s` in internal configuration file and then, could not find user default group (PRMID = 1) in file.

Action Ensure configuration file /etc/prmconf or the specified file contains the group and user specifications you expect. Then reconfigure PRM using a `prmconfig -k` or `-i` command to resync the internal configuration file.

404

Message	`Group name is too long.`
Cause	The group name length is longer than allowed.
Action	Check group name.

407

Message	`Could not move process %d to group %s`
Cause	Internal system failure.
Action	Ensure the PRM group and PID still exist.

408

Message	`Could not move process group %d to group %s:` (HP-UX error message) `(perror)`
Cause	Internal system failure.
Action	Ensure the PRM group and PID still exist.

409

Message	`User %s does not have permission to move process %d.`
Cause	User `%s` is not superuser and does not own this process. A nonroot user must own all processes to be moved and have access to the target group.
Action	Ensure you have the correct PID. Log in as superuser and try again.

411

Message	`User %s does not have permission to move user %s.`
Cause	User `%s` is not superuser and does not own the processes of user `%s`. A nonroot user must own all processes to be moved and have access to the target group.
Action	Log in as superuser and try again.

412

Message	`User %s does not have permission to use group %s.`
Cause	User `%s` is not superuser and does not have access to group `%s`. A nonroot user must own all processes to be moved and have access to the target group.
Action	Verify that user has access to the desired group by executing the `prmmove` command without any options. If user does not have access, choose an alternate group or request access to the group. Otherwise, log in as superuser and try again.

413

Message	`Could not move user %s to group %s:` (HP-UX error message) `(perror)`
Cause	Internal system failure.
Action	Contact system support staff.

417

Message	`Could not find group %s in configuration file.`
Cause	Cannot find PRM group/CPU record for this group in internal configuration file. Cause may be a misspelling of the PRM group's name on the `prmmove` command line or a corrupt PRM internal configuration file (/var/tmp/PRM.prmconf).
Action	Verify the spelling of the PRM group name on the `prmmove` command line. If that is correct, verify that /etc/prmconf or the specified file has the correct information in it (PRM group/CPU record for desired target group). Then reconfigure PRM using `prmconfig -k` or `-i` to resync internal configuration file.

`418`

Message	`Please specify %s.`
Cause	The command line is missing arguments for `-p`, `-g`, or `-u` options.
Action	Re-execute the command with the appropriate argument type: process ID, process group ID, or user login.

`419`

Message	`%s requires users to be specified by login names.`
Cause	Cannot use user ID number (UID) as argument to `-u` option. User login name is required argument for `-u` option.
Action	Re-execute command replacing user ID numbers with user login names.

`420`

Message	`%s requires that PRM be configured.`
Cause	PRM is not configured.
Action	Configure PRM with `prmconfig -k` or `-i` before executing `prmmove` command.

`423`

Message	`Could not find process %d.`
Cause	Verify that indicated process ID is valid.
Action	If process ID not valid, try command again with correct process ID, otherwise no action is possible.

`424`

Message	`Could not find process group %d.`
Cause	Verify that indicated process group ID is valid.
Action	If process group ID is not valid, try command again with correct process group ID, otherwise no action is possible.

426

Message	`Could not find internal configuration file %s.`
Cause	Could not open internal configuration file `%s` for reading.
Action	Make sure file exists and is readable. Reconfiguring PRM with `prmconfig -k` or `-i` recreates the internal file and resyncs it with /etc/prmconf or the specified configuration file.

428

Message	`%d is not a process group id.`
Cause	`%d` is not a valid process group ID; it is simply a process ID.
Action	Re-execute `prmmove` command using the `-p` option.

429

Message	`Process id %s is invalid.`
Cause	The argument `%s` is not a valid process ID number.
Action	Re-execute `prmmove` command using a valid process ID number.

430

Message	`Process group id %s is invalid.`
Cause	The argument `%s` is not a valid process group ID number.
Action	Re-execute `prmmove` command using a valid process group ID number.

prmrun error messages

601

Message `Could not find configured application.`

Cause Could not find the application record in the configuration file. Possible causes are:

- Could not find the full path of the application specified on the command line.
- User’s `PATH` environment variable is empty.
- The application either does not exist, is empty, or is not executable.
- The assigned group does not exist.
- Unable to obtain work area (memory) needed for internal `prmrun` processing.

Action Take the appropriate action as indicated in the accompanying messages.

602

Message `Not enough resources for internal processing.`

Cause Unable to obtain work area (memory) needed for internal `prmrun` processing.

Action Contact system support staff.

603

Message `Could not find access list for user %s.`

Cause Cannot find PRM user record for `%s` in internal configuration file, and then could not find user default group (PRMID = 1) in file.

Action Ensure configuration file /etc/prmconf or the specified file contains the group and user specifications you expect. Then reconfigure PRM using a `prmconfig -k` or `-i` command to resync the internal configuration file.

604

Message	`User's PATH environment variable is empty.`
Cause	User’s `PATH` environment variable is not set.
Action	Add application’s directory to `PATH` environment variable and retry `prmrun` command.

606

Message	`Could not launch application %s in group %s (perror)`
Cause	Exec of command `%s` failed for the reason indicated in message.
Action	Take action necessary to resolve indicated failure and retry `prmrun` command.

607

Message	`Application file %s does not exist.`
Cause	The application file `%s` does not exist.
Action	Make sure the file specified on the command line is an application and that it is in the correct directory.

608

Message	`Application file %s is empty.`
Cause	The application file `%s` is empty.
Action	Make sure the file is an application and replace it with a nonempty version.

609

Message	`Application file %s is not executable.`
Cause	The application file is not executable or is not a regular file.
Action	Make sure `%s` is executable and is a regular file.

611

Message `Could not find application %s in the configuration file.`

Cause Could not find the application record in the configuration file.

Action Make sure the syntax of the application parameter is correct and that the application's directory is in the user's `PATH` environment variable.

If the application does not have a record in the configuration file, use `prmrun -g` *`targetgrp`* to start the application in the group *`targetgrp`*.

612

Message `User %s does not have permission to use group %s.`

Cause Exec of command `%s` failed for the reason indicated in message.

Action Take action necessary to resolve indicated failure and retry `prmrun` command.

613

Message `Application file %s:` (HP-UX error message) `(perror)`

Cause Unable to get the system information for application file for the reason indicated in the message.

Action Take action appropriate to resolve the cause indicated by the message.

617

Message `Could not find group %s in configuration file.`

Cause Cannot find PRM group/CPU record for this group in internal configuration file. Cause may be a corrupt PRM internal configuration file (/var/tmp/PRM.prmconf).

Action Verify that /etc/prmconf or the specified file has the correct information in it (PRM group/CPU record for desired target group). Then reconfigure PRM using `prmconfig -k` or `-i` to resync internal configuration file.

618

Message `Please specify application.`

Cause Missing application parameter on command line.

Action Supply application parameter and retry `prmrun` command.

619

Message `Please use either -g or -i.`

Cause Options `-g` and `-i` cannot be used together.

Action Specify either `-g` or `-i` and retry `prmrun` command.

620

Message `%s requires that PRM be configured.`

Cause PRM is not configured.

Action Configure PRM with `prmconfig -k` or `-i` before executing `prmrun` command.

626

Message	`Could not find internal configuration file %s.`
Cause	Could not open internal configuration file `%s` for reading.
Action	Make sure file exists and is readable. Reconfiguring PRM with `prmconfig -k` or `-i` will recreate internal file and resync it with /etc/prmconf or the specified file.

629

Message	`%s has alternate names, do not launch with prmrun.`
Cause	The `prmrun` command requires a record with no alternate names for the application; it did not find one.
Action	Modify the configuration file to contain an application record without alternate names, or run the application without using `prmrun`.

prmlist error messages

803

Message	`No Group records in the configuration file.`
Cause	Could not find any group/CPU records in the internal configuration file.
Action	Reconfigure and retry the `prmlist` command.

805

Message	`No User records in the configuration file.`
Cause	Could not find any user records in the internal configuration file.
Action	Add user records as needed.

`806`

Message `No Compartment records in the configuration file.`

Cause Could not find any compartment records in the internal configuration file.

Action Add compartment records as needed.

`807`

Message `Please specify only one -g option.`

Cause More than one `-g` option was specified on the command line.

Action Specify only one `-g` option and retry the `prmlist` command.

`808`

Message `Please specify only one -u option.`

Cause More than one `-u` option was specified on the command line.

Action Specify only one `-u` option and retry the `prmlist` command.

`809`

Message `Please specify only one -a option.`

Cause More than one `-a` option was specified on the command line.

Action Specify only one `-a` option and retry the `prmlist` command.

`810`

Message `Please specify only one -d option.`

Cause More than one `-d` option was specified on the command line.

Action Specify only one `-d` option and retry the `prmlist` command.

811

Message `Device name %s not legal.`

Cause Name given is not a logical volume group.

Action Check the spelling, then use `bdf` to check whether the device is mounted.

812

Message `Could not find full path of application %s.`

Cause The full path of the application parameter could not be found.

Action Make sure the syntax of the application parameter is correct.

813

Message `Please specify only one -s option.`

Cause More than one `-s` option was specified on the command line.

Action Specify only one `-s` option and retry the `prmlist` command.

814

Message `-s not valid. Compartments not available.`

Cause The `-s` option was specified on the command line to get compartment information; however, the configuration does not include compartments.

Action Do not specify `-s` option; or, add compartments to the configuration and retry the `prmlist` command.

815

Message `Please specify only one -G option.`

Cause More than one `-G` option was specified on the command line.

Action Specify only one `-G` option and retry the `prmlist` command.

816

Message `Unix group` name is too long.

Cause The Unix group name is more than 255 characters.

Action Change the Unix group name to be no more than 255 characters and update the PRM configuration to use the new name.

817

Message `Could not find group %s in the configuration file.`

Cause Could not find record for group `%s` in the internal configuration file.

Action Add group/CPU record to configuration file, if needed, and reconfigure.

818

Message `Could not find user %s in the configuration file.`

Cause Could not find record for user `%s` in the internal configuration file.

Action Add user record to configuration file, if needed, and reconfigure.

819

Message `Could not find application %s in the configuration file.`

Cause Could not find record for application `%s` in the internal configuration file.

Action Add application record to configuration file, if needed, and reconfigure.

820

Message `%s requires that PRM be configured.`

Cause PRM is not configured.

Action Configure PRM with `prmconfig -k` or `-i` before executing `prmlist` command.

822

Message	`No members found for netgroup %s for this machine and domain.`
Cause	An empty or nonexistent netgroup was specified in a user record.
Action	Check the spelling in the PRM configuration file against the spelling in the /etc/netgroup file and correct if necessary. Alternatively, if the configuration is used on multiple systems and the netgroup name is valid on one of the other systems, do nothing.

823

Message	`Could not find compartment %s.`
Cause	Name given is not a compartment.
Action	Check the spelling.

824

Message	`Could not find Unix group %s.`
Cause	Name given is not a Unix group.
Action	Check the spelling.

831

Message	`Device record for %s not found.`
Cause	Name given is not a logical volume group.
Action	Check the spelling, then use `bdf` to check whether the device is mounted.

846

Message	`Could not find configuration file name.`
Cause	Could not find the name of the original configuration file in the first two lines in the PRM internal working file.
Action	Reset PRM with `prmconfig -r` then load a configuration and enable PRM.

847

Message `Could not find configuration file modification date.`

Cause Could not find the time of last modification in the first two lines in the PRM internal working file.

Action Reset PRM with `prmconfig -r` then load a configuration and enable PRM.

prmloadconf error messages

901

Message `Must have root capability to use prmloadconf.`

Cause The command was executed by a nonroot user.

Action Log in as root and execute the command.

924

Message `Please specify only one -f option.`

Cause More than one `-f` option was specified on the command line.

Action Specify only one `-f` option and retry the `prmloadconf` command.

925

Message `Could not create configuration file %s. Please check path.`

Cause The configuration file could not be created because of an invalid path.

Action Create the directories given in the path and retry.

929

Message	`Unable to further append to file %s. Please check file system space.`
Cause	There is no disk space available.
Action	Free up disk space and retry.

930

Message	`prmloadconf may not change PRM internal configuration file %s`
Cause	Specifying the internal configuration file as the argument to the `-f` option is not allowed.
Action	Specify another file as the `-f` argument.

prmrecover error messages

1001

Message	`Unrecognized prmrecover resource argument.`
Cause	The resource argument on the command line is not recognized by `prmrecover`.
Action	Re-enter command and include a recognized argument. The recognized argument is `MEM` for recover processes suppressed by PRM memory manager.

1002

Message	`A resource argument is required for %s.`
Cause	No resource argument on command line; must identify the manager to recovery operation.
Action	Re-enter command and include resource argument. The recognized argument is `MEM` for recover processes suppressed by PRM memory manager.

1005

Message `Must shutdown memory manager before doing recovery.`

Cause Recovery of suppressed processes is not allowed while memory manager is running.

Action Shutdown the PRM memory manager by entering `prmconfig -r` before proceeding with recovery.

1006

Message `Recovery cannot proceed during OL activity. Please try again later.`

Cause Recovery of suppressed processes is not allowed while online cell operations are in progress.

Action Wait for the online cell operations to complete and then try `prmrecover` again.

1007

Message `%s: Could not get space for internal tables: %s.`

Cause Internal system failure.

Action Contact system support staff.

1008

Message `%s takes only one argument.`

Cause More then one command-line argument was used.

Action Check command syntax and re-enter command using only one command-line argument.

1009

Message `No memory recovery necessary.`

Cause Memory recovery is not necessary.

Action None; memory is automatically recovered.

1161

Message	`Cleaning up processes`
Cause	Informational message.
Action	None.

1162

Message	`Cleaning up groups`
Cause	Informational message.
Action	None.

1171

Message	`Could not disable kernel memory feature`
Cause	Could not disable in-kernel memory controls.
Action	Contact system support staff.

1172

Message	`Successfully disabled kernel memory feature`
Cause	Informational message.
Action	None.

prmavail error messages

1201

Message	`Unrecognized prmavail resource argument.`
Cause	The resource argument on the command line is not recognized by `prmavail`.
Action	Re-enter command and include a single, recognized resource argument. Recognized arguments are: `CPU` for number of cores, `DISK` for data on logical volume groups, and `MEM` for real memory pages.

1205

Message `prmavail takes only three arguments.`

Cause More than three command-line arguments were used.

Action Check command syntax and re-enter command using up to three command-line arguments.

1208

Message `Disk Bandwidth Manager not available in this kernel.`

Cause Disk bandwidth controls not available on the system.

Action Do not specify the `DISK` option for this command on systems where disk bandwidth controls are not available.

prmanalyze error messages

1501

Message `illegal resource type %s`

Cause The specified resource is not valid.

Action Re-enter the command using a valid type: `disk`, `mem`, or `cpu`.

1502

Message `illegal sort key %s`

Cause The specified sort key is not valid.

Action Re-enter the command using a valid sort key: `uid`, `gid`, `command`, or `prmid`.

1503

Message	`illegal report type %s`
Cause	The requested report type is not valid.
Action	Re-enter the command using a valid report type: `summary`, `conflict`, `hourly`, `daily`, `weekly`, or `monthly`.

1504

Message	`key type 'auto' only allowed with report type 'summary'`
Cause	You tried to use the key type `auto` with a different report.
Action	Use the key type `auto` with the report type `summary`.

1505

Message	`only one density threshold argument (-d) allowed`
Cause	More than one `-d` option was specified.
Action	Re-enter the command specifying `-d` only once.

1506

Message	`only one config file argument (-f) allowed`
Cause	More than one configuration file argument was used.
Action	Check command syntax and re-enter command using only one config file argument.

1507

Message	`only one resource argument (-r) allowed`
Cause	The `-r` option was entered more than once.
Action	Re-enter the command using `-r` only once.

1508

Message	`only one sort key argument (-s) allowed`
Cause	The `-s` option was entered more than once.
Action	Re-enter the command using `-s` only once.

1509

Message	`only one report type argument (-t) allowed`
Cause	The `-t` option was entered more than once.
Action	Re-enter the command using `-t` only once.

1510

Message	`unable to access file %s`
Cause	The file does not exist or the directory permissions for the directory where the file resides do not allow access.
Action	Check the directory permissions and filename.

1511

Message	`unable to read file %s`
Cause	File permissions do not allow reading.
Action	Change the file permissions.

1512

Message	`unable to write to temp file`
Cause	There is no space available for writing the file.
Action	Check the amount of disk space and remove files as possible.

1513

Message	`unable to allocate space after %d %s`
Cause	The accounting files have too many records to process.
Action	Reduce the number of accounting files or raise the system's memory-per-process value.

1514

Message	`unable to create temp file in /tmp`
Cause	There is not enough space or you are not running the command as superuser.
Action	Check disk space, log in as superuser, and try again.

`1515`

Message	`unable to open temp file %s`
Cause	There is not enough disk space or the file has been removed.
Action	Check disk space in /tmp and rerun the command.

`1516`

Message	`Internal data structures corrupt %d. Verify accounting file format with acctcom.`
Cause	File is not an accounting file.
Action	Use `acctcom` to confirm file does not contain accounting data.

`1518`

Message	`unable to read event temp file %s`
Cause	File has been removed externally.
Action	Rerun `prmanalyze`.

`1519`

Message	`event temp file contains unknown sort key %d`
Cause	`prmanalyze` detected a corrupt data format.
Action	Contact system support staff.

`1520`

Message	`event temp file contains unknown sort key %s`
Cause	`prmanalyze` detected a corrupt data format.
Action	Contact system support staff.

1521

Message `illegal prm group number %s`

Cause When sorting by `prmid`, `-x` was specified with an argument that is nonnumeric, less than 0, greater than 63, or greater than 255 (starting with HP-UX 11i v2 Update 2).

Action Re-enter the command using a number from 0 to 63, or 0 to 255 depending on your HP-UX version, as the argument to `-x`.

1522

Message `illegal user %s`

Cause When sorting by `uid`, user `%s` was given as an argument to `-x`; however, the user does not exist in /etc/passwd.

Action Check the spelling of the user's login name or create an account for the user.

1523

Message `illegal UNIX group %s`

Cause When sorting by `gid`, the group `%s` was given as an argument to `-x`; however, the group does not exist in /etc/group.

Action Check the spelling of the group name or create the group.

1525

Message `ambiguous application string %s`

Cause The string entered was ambiguous.

Action Enter a non-ambiguous string.

1526

Message `illegal minimum duration %s`

Cause The minimum duration was not valid.

Action Enter a valid duration.

`1527`

Message	`exclusion option not permitted with autogenerate option`
Cause	You used the exclusion option.
Action	Do not use the exclusion option.

`1528`

Message	`the option \"-%c\" requires an argument`
Cause	No option argument was used.
Action	Check command syntax for correct option usage.

`1529`

Message	`the -d option requires a floating point argument`
Cause	An invalid floating-point argument was used.
Action	Check command syntax for correct option usage.

prmagt error messages

`1601`

Message	`error: must be root to execute`
Cause	The command was executed by a nonroot user.
Action	Log in as root and execute the command.

`1602`

Message	`unrecognized option: %s`
Cause	The specified option is not a valid option.
Action	Try the command again using `-plock`, `-stop`, or `-interval` *seconds*.

1603

Message	`error: unable to read file %s`
Cause	The file /var/opt/prm/prmagt.pid is corrupt or 0-length.
Action	Kill the currently running `prmagt` process, remove the prmagt.pid file, and start `prmagt` again.

1604

Message	`error: prmagt already running, pid %d`
Cause	The `prmagt` command was executed while the agent is already active.
Action	None. The agent is running.

1609

Message	`error: illegal interval '%s'. use a number between 1 and %d`
Cause	The specified interval is not valid.
Action	Retry with a value in the indicated range.

Glossary

alternate name Other names assigned to processes spawned by an application. This is most common for complex programs such as database and mail programs that launch many processes and rename them.

alternate group A PRM group other than the user's initial group that a user can access using `prmrun` or `prmmove`. For users, these groups are listed in their user records (or their netgroups' user records) in the PRM configuration file following the initial group. Root users can access all PRM groups, so alternate groups need not be specified in their user record.

application manager A daemon that polls the PRM configuration file and the running processes to ensure all processes are in the proper PRM groups.

application record Record in a PRM configuration file that specifies the PRM group an application is to run in. This record can optionally specify any alternate names an application may take upon execution.

available memory The amount of real memory not reserved for the kernel or root processes. Available memory is used by the system for executing user processes.

child group In a hierarchy, a PRM group that has a parent group.

compartment You create a compartment configuration using the HP-UX feature Security Containment, which is available starting with HP-UX 11i v2 (B.11.23). You can also use a PRM utility such as `srpgen` or `prm2scomp`. PRM then allows you to map your compartments to PRM groups so you can control resource allocation.

configuration file File (/etc/prmconf by default) that PRM uses to determine group names, resource shares, applications' assigned groups, and other items. Additional configuration files are typically stored in the directory /etc/opt/prm/conf, with the owner set to hpsmh. You can edit these files with a text editor, the PRM interface in HP System Management Homepage, or the PRM interface in HP Systems Insight Manager.

core The actual data-processing engine within a processor. A single processor might have multiple cores. A core might support multiple execution threads, as explained in the section "Hyper-Threading" on page 49.

CPU cap An upper limit on a group's CPU resource use. PRM caps CPU consumption for FSS PRM groups using either `CPUCAPON` mode (enabled through `prmconfig`) or per-group capping (available for HP-UX 11i v3 and later), which uses the `MAX` field in the group record.

CPU manager PRM uses the Fair Share Scheduler (FSS) to manage CPU resources for FSS PRM groups. For PSET PRM groups, processes have equal access to CPU cycles through the HP-UX standard time-share scheduler.

disk group A single logical disk device under control of VERITAS Volume Manager (VxVM) formed from one or more physical disk drives. PRM manages disk bandwidth on a disk group basis as well as a logical volume group basis.

disk manager A kernel routine that monitors bandwidth at the level of logical volume groups (LVM) and disk groups (VxVM), rearranging I/O requests as needed to ensure disk bandwidth shares.

disk bandwidth record (Also known as “disk record.”) Record in a PRM configuration file that specifies a group’s disk bandwidth shares for a given logical volume group or disk group.

effective user ID A form of user ID that can allow users access to files they do not own.

entitlement The minimum percentage (lower limit) of CPU, memory, or disk bandwidth resources guaranteed to a particular PRM group when the total system use of these resources is at 100%.

file ID ID used by the application manager to place processes in the appropriate PRM groups. The file ID is based on the file system device and inode number.

group/CPU record Record in a PRM configuration file that specifies a PRM group’s name and its CPU allocation. PRM requires two groups: `PRM_SYS` (PRMID 0) for system processes and `OTHERS` (PRMID 1) for users without user records. PRM automatically creates the `PRM_SYS` group.

hierarchy An FSS PRM group hierarchy is a nesting of groups. You specify resource shares at each level of the hierarchy. If a group has child groups, the parent group’s resource shares are distributed to the children based on the shares they are assigned. If a group has no child groups, it uses the shares itself.

HP-UX real-time process A process that uses the HP-UX real-time scheduler (`rtprio`). This type of process keeps its assigned priorities because timely scheduling is crucial to the operation of a real-time process. Hence, a real-time process is permitted to exceed its group’s CPU share and max.

initial group The first PRM group listed in a user record in a configuration file. Typically, the applications a user launches run in the user’s initial group—assuming those applications do not have their own application records. This is the group `prmconfig`, `prmmove -i`, `login`, `at`, and `cron` use to determine where to place user processes. If a user does not have a user record or is not in a netgroup that has a user record, the user default group `OTHERS` becomes the user’s initial group.

leaf group Any PRM group that has no children (child groups). In a configuration that does not use group hierarchies, all the groups are leaf groups.

lockable memory Memory that can be locked (that is, its pages kept in real memory for the lifetime of a process) by the kernel, by `mlock()`, or by `plock()` is known as lockable memory. Locked memory cannot be paged or swapped out.

logical volume group A single logical disk device under control of Logical Volume Manager (LVM) formed from one or more physical disk drives. PRM manages disk bandwidth on a logical volume group basis, as well as a disk group basis.

Logical Volume Manager (LVM) A disk-management tool used to partition physical disk drives.

memory cap An upper limit on a PRM group's memory use.

memory isolation A way of separating a PRM group's memory so that it cannot loan out to, or borrow memory from, other groups.

memory manager A daemon that monitors use of real memory on the system to ensure that PRM groups are granted their memory allocations of private memory and shared memory. This daemon also enforces capping of private memory when requested.

memory record Record in a PRM configuration file that specifies a group's memory allocation, either of private memory or shared memory.

MRG Memory Resource Group.

NFS Network File System.

`OTHERS` group The PRM group `OTHERS` with PRMID 1. PRM uses this group as the initial group for any user who does not have a PRM user record in the PRM configuration file.

parent group Any PRM group in a hierarchy that has child groups.

PID Process ID.

polling interval Amount of time a resource manager waits between its pollings of the system to determine application placement or resource use. The polling interval is only used by the application manager (`APPL`) and the memory manager (`MEM`).

POSIX real-time process A process that uses the POSIX.4 real-time scheduler (`rtsched`). This type of process keeps its assigned priorities because timely scheduling is crucial to the operation of a real-time process. Hence, such a process is permitted to exceed its CPU shares.

PRM administrator A person responsible for PRM configuration. This person has root user capabilities.

PRM group Collection of users and applications that are joined together and assigned certain amounts of CPU, memory, and disk bandwidth resources. Each group has a name and PRMID. These groups are defined in a PRM configuration file. A PRM group record may define a traditional PRM group (FSS PRM group) or a PSET PRM group.

PRM group ID PRMID.

PRMID A value that may be used in place of the PRM group name. For FSS PRM groups, it is an integer between 0 and 63 (inclusive) or between 0 and 255 (inclusive) starting with HP-UX 11i v2 Update 2. PRMIDs for PSET PRM groups are assigned by PRM. PRMID 0 (`PRM_SYS`) is reserved for the system group. PRMID 1 (`OTHERS`) is reserved for the user default group.

PRM_SYS group The PRM group PRM_SYS with PRMID 0. PRM places all system processes in this group by default. System processes are processes started by someone with UID 0.

process group Every process (except system processes, such as init and swapper) belongs to a process group. (Process groups are different from PRM groups.) A newly created process joins the process group of its creator. When you create a job, the shell assigns all the processes in the job to the same process group. Signals can propagate to all processes in a process group; this is a principal advantage of job control.

process group ID Each process group is uniquely identified by an integer called a process group ID. Each process group also has a process group leader. The process group's ID is the same as the process ID of the process group leader. Every process in a process group has the same group ID.

process ID An integer, assigned to a process at creation, that uniquely identifies the process to HP-UX.

processor set A subset of the system's cores. The default processor set consists of all cores on the system.

proportional overachievement The ratio of memory used to memory entitlement for a group, compared to the average of all groups. If a PRM group is overachieving compared to the average, then the number of import pages for that group is reduced, allowing other groups to start importing the newly available memory.

real memory Real memory is shared by all processes. The data and instructions of any process (a program in execution) must be available to the core by residing in real memory at the time of execution.

real user ID An integer, assigned to a user at login, that uniquely identifies the username to HP-UX.

resource manager Tool that either controls the amount of a resource that a PRM group uses or ensures applications run in their appropriate PRM groups. Resource managers include the application manager (APPL), the CPU manager (CPU), the disk bandwidth manager (DISK), and the memory manager (MEM).

secure compartment See compartment.

Secure Resource Partition You form a secure resource partition by mapping a secure compartment to a PRM group. (Create secure compartment configurations using the HP-UX feature Security Containment—or a PRM utility such as srpgen or prm2scomp.) These partitions allow you to combine the security and resource allocation features of Security Containment and PRM.

Available starting with HP-UX 11i v2 (B.11.23).

shares Resource allocations for CPU (for FSS PRM groups), private memory, and disk bandwidth are specified in shares. A share is a guaranteed minimum when the system is at peak load. PRM allocates a percentage of the system resource to each PRM group based on its number of shares relative to the sum of it and its siblings' number of shares.

sibling group PRM group that shares a parent group with one or more other PRM groups. Resource shares are distributed recursively to sets of sibling groups in a hierarchy.

system administrator A person responsible for day-to-day system configuration and maintenance. This person has root user capabilities.

system group The PRM group `PRM_SYS` with PRMID 0. PRM places all system processes in this group by default.

UID Refers to both real and effective user IDs.

user A user is any person using the system. Each user has a unique name and ID, corresponding to their login and real user ID defined in password files (such as /etc/passwd) accessible by the C function `getpwnam`.

user default group The PRM group `OTHERS` with PRMID 1. PRM uses this group as the initial group for any user who does not have a PRM user record in the PRM configuration file.

user record Record in a PRM configuration file that specifies a user name, an initial group that the user's processes should run in, and optionally any alternate groups the user should be able to run processes in.

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