Parallel System Support Programs for AIX

Administration Guide

Version 3 Release 2

SA22-7348-02

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SA22-7348-02

Note!

Before using this information and the product it supports, read the information in "Notices" on page 599.

Third Edition (April, 2000)

| This edition applies to version 3 release 2 of the IBM Parallel System Support Programs for AIX (PSSP) Licensed Program (product
| number 5765-D51) and to all subsequent releases and modifications until otherwise indicated in new editions. This edition replaces
| SA22-7348-01. Significant changes or additions to the text and illustrations are indicated by a vertical line (|) to the left of the change.

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About This Book

This book contains information to help you understand and perform SP system administration. It includes concepts and instructions pertaining to:

- Understanding IBM RS/6000 Scalable POWERparallel (SP) systems
- Performing routine system administration tasks
- Making the system secure
- Managing sets of nodes
- Monitoring the system
- Providing for system availability and problem management
- Understanding and using the Communications Low-level Application Programming Interface (LAPI)

Additional task information for system administrators is covered in separate manuals.

For a list of related books and information about accessing online information, see the Bibliography in the back of the book.

| This book applies to PSSP Version 3 Release 2. To find out what version of PSSP is running on your control workstation (node 0), enter the following:

```
splst_versions -t -n0
```

In response, the system displays something similar to:

```
| 0 PSSP-3.2
```

| If the response indicates **PSSP-3.2**, this book applies to the version of PSSP that is running on your system.

To find out what version of PSSP is running on the nodes of your system, enter the following from your control workstation:

```
splst_versions -G -t
```

In response, the system displays something similar to:

```
| 1 PSSP-3.2
| 2 PSSP-3.2
| 7 PSSP-3.1.1
| 8 PSSP-2.4
```

| If the response indicates **PSSP-3.2**, this book applies to the version of PSSP that is running on your system.

If you are running mixed levels of PSSP, be sure to maintain and refer to the appropriate documentation for whatever versions of PSSP you are running.

Who Should Use This Book

This book is intended for system administrators responsible for setting up and maintaining the SP system. It assumes the administrators have a working knowledge of AIX or UNIX and experience with network systems.

The System Administrators Guide of USENIX (SAGE), has developed a classification for skills required for system administration as published in “Job Descriptions for System Administrators.” Administrators of small SP systems (one or two frames in a relatively simple environment) are expected to have level II skills (Junior System Administrator). Administrators of larger SP systems are expected to have level III skills (Intermediate/Advanced System Administrator).

Parts of this book can also be used by system operators or others that need to monitor the status of the hardware and software or interact with the power and reset controls.

Typographic Conventions

This book uses the following typographic conventions:

Typographic	Usage
Bold	**Bold** words or characters represent system elements that you must use literally, such as commands, flags, and path names.
Italic	• *Italic* words or characters represent variable values that you must supply. • *Italics* are also used for book titles and for general emphasis in text.
`Constant width`	Examples and information that the system displays appear in `constant width` typeface.
[ ]	Brackets enclose optional items in format and syntax descriptions.
{ }	Braces enclose a list from which you must choose an item in format and syntax descriptions.
|	A vertical bar separates items in a list of choices. (In other words, it means “or.”)
< >	Angle brackets (less-than and greater-than) enclose the name of a key on the keyboard.
...	An ellipsis indicates that you can repeat the preceding item one or more times.
<**Ctrl-*x***>	The notation <**Ctrl-*x***> indicates a control character sequence. For example, <**Ctrl-c**> means that you hold down the control key while pressing <**c**>.
\	The continuation character is used in coding examples in this book for formatting purposes.

Interface Instructions

Some sections of this book give step-by-step instructions for performing tasks with a graphical user interface. The instructions use a format that distinguishes between the user action and the system response.

User actions appear in uppercase bold type.

PRESS Cancel

Selections from a menu bar are indicated with an →.

SELECT SP → Topology

The system response to an action follows the • symbol. For example:

- The diagnostic display appears.

RS/6000 SP System Overview

Chapter 1. SP System Overview

This chapter provides an introduction to the IBM Parallel System Support Programs for AIX (PSSP), which is the IBM RS/6000 Scalable POWERparallel (SP) system administration software, and other IBM licensed program products that work cooperatively with PSSP.

For a *brief* overview of the SP system hardware components, and for planning and preparing to install or to migrate to the latest PSSP and PSSP-related software, see the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*. For detailed hardware specifications see the book *IBM RS/6000 SP: Planning Volume 1, Hardware and Physical Environment*. Remember to use the edition of the book that relates to the release of PSSP that you have or in which you are interested.

The SP system software includes:

- AIX, the base operating system.
- PSSP, the higher-level set of support programs and interfaces that enables you to take advantage of the powerful parallel processing features of the SP system.
- Other IBM licensed program products (LPPs).
- Independent software vendor products.

Introduction

SP systems offer an information processing solution with the following characteristics:

- Scalable

  Standard SP system configurations of one to 128 processor nodes in SP frames are supported.

  You can have a computer system that is independent of the SP system, comprised solely of a control workstation running the PSSP 3.2 software and connected to each of up to sixteen RS/6000 Enterprise Servers (models S70, S70 Advanced, or S80) running the PSSP software. For the sake of discussion, these are referred to as *clustered enterprise servers.* Such a system functions like an SP system with some limitations resulting from the hardware differences. ***Except where otherwise noted, discussions in this book apply to a system of clustered enterprise servers running PSSP as well as to an SP system.***

  Any RS/6000 Enterprise Server S70, S70 Advanced, or S80 can be part of a system of *clustered enterprise servers* or it can be within a standard SP system, in which case it is referred to as an *SP-attached server*. These terms signify the system configurations in which an RS/6000 Enterprise Server participates when it is managed by the PSSP software. ***Except where otherwise noted, statements in this book about function on SP nodes apply also to SP-attached servers and clustered enterprise servers.***

  You can expand either system over time to meet your changing computing requirements.

- Parallel computing

  The SP system provides a strong platform for parallel application development and execution. System management applications provided by the PSSP software, the SP switch network, and related IBM LPPs, such as IBM Parallel Environment for AIX, enhance the parallel computing capabilities of the SP system.

- Cost effective

  Because the SP system is based on AIX and RS/6000 technology, thousands of existing RS/6000 applications can be run on the SP system, eliminating the need for costly reprogramming.

  The scalability of the SP system ensures that hardware and software invested in now will continue to serve you over time.

- Support of open system standards

  The SP system accommodates a wide number and variety of I/O attachments and disk storage.

  Enablers are provided that permit a number of commercial applications to exploit the parallel capabilities of the SP system.

- Flexibility

  The PSSP software allows you to run various combinations of serial, parallel, batch and interactive jobs concurrently.

- Simplified operation

  The control workstation serves as a single point of control for installing, managing, and monitoring the SP system. It can also manage and monitor IBM Netfinity servers.

- National Language Support (NLS)

  The PSSP software is NLS-enabled. This means that the software has been made translation-ready and can be translated to any language that is supported by AIX.

These features and capabilities make the SP an outstanding system for technical computing in a variety of market segments including Engineering Analysis, Chemistry, and Seismic/Petroleum. At the same time, the SP system is an excellent choice for the parallel commercial market, supporting database query, business management, decision support, online transaction processing, and batch business applications.

AIX

AIX is an integrated UNIX operating environment conforming to industry standards for open systems. It provides the basic operating system functions such as the AIXwindows user interface, extended real-time support, network installation management, advanced file system support, physical disk space management, and a platform for application development and execution. AIX capabilities that some PSSP components use for SP system management include the following:

- The Network Installation Management (NIM) environment provides the ability to install an AIX **mksysb** image over the network.

- The Logical Volume Manager (LVM) improves data management productivity, enables files to span multiple disk drives, and provides, through disk mirroring, a high availability option for critical data.
- The System Management Interface Tool (SMIT) provides a single, consistent, and expandable interface to system management commands.
- The System Resource Controller (SRC) simplifies the management of subsystems and daemons.
- AIX device support lets you add and delete devices at any time without disrupting the system.

PSSP

The PSSP software is a comprehensive suite of applications to manage an SP system as a full-function parallel processing system. It provides a single point of control for administrative tasks and helps increase productivity by letting administrators view, monitor, and control how the system operates. The PSSP software is discussed in terms of functional entities called components of PSSP. Most functions are base components of PSSP while others are optional; they come with PSSP, but you choose whether to install and use them.

Highlights

The components of PSSP are summarized and introduced in this section.

Notes:

1. If you are running mixed levels of the PSSP software, be sure to keep and refer to the respective documentation for each version of PSSP you are running.
2. The SP Print Management System has been removed as of PSSP 2.3. That is, the SP Print Management System cannot be configured on nodes running PSSP 2.3 or later. IBM suggests you use the Printing Systems Manager (PSM) for AIX as a more general solution to managing printing on the SP system. However, if you are running earlier versions of PSSP on some of your nodes, the SP Print Management System is still supported on those nodes. The **print_config** routine running on the control workstation will configure the SP Print Management System on nodes running versions of PSSP earlier than PSSP 2.3.
3. There is some information on tuning, such as setting initial tuning parameters or reviewing sample tuning files, in the book *PSSP: Installation and Migration Guide*. Other tuning information that used to be in this book (PSSP Administration Guide) is now available at the Web address http://www.rs6000.ibm.com/support/sp/

The SP Resource Center

The SP Resource Center provides one simple interface for all softcopy SP documentation and information resources. It consists of HTML, Java, and Javascript files and works with a Web browser. The Resource Center provides access to a variety of information including publications, READMEs, Redbooks, White Papers, product information, as well as up-to-date service information.

Installation

The Network Installation Management (NIM) environment supports the installation of AIX 4.2.1 and later versions on nodes.

Configuration Management

Node configuration data is entered into the System Data Repository (SDR) using SMIT or line commands. The SDR provides storage and retrieval of system data across the control workstation, file servers, and nodes.

Security

- Authentication and authorization for the AIX remote commands can be performed using one or more of the following:
  1. The Kerberos V5 method provided by the Distributed Computing Environment (DCE) software.
  2. The Kerberos V4 method using either the PSSP or the Andrew File System (AFS) components.
  3. The standard AIX method.
- Optional authentication and authorization services are provided for use by *SP trusted services*. Methods used by services in prior PSSP releases (including Kerberos V4) and DCE can be used individually, in combination, or not at all.

Operation

The following are available to help you operate and manage your SP system:

- ***SP TaskGuides***

  SP TaskGuides are a form of advanced online assistance designed to walk you through complex or infrequently performed tasks. Each TaskGuide does not simply list the required steps. It actually performs the steps for you, automating the steps to the highest degree possible and prompting you for input only when absolutely necessary. You might recognize them as *wizards*.

  The following TaskGuides are available:
  – Set Site Environment Information
  – Add Frames
  – Configure New Nodes
  – Create Node Image
- ***SP Perspectives***

  This is a set of graphical user interfaces (GUIs) which can simplify your work, such as:
  – Monitor and control hardware
  – Create and monitor system events
  – Manage IBM virtual shared disks
  – Generate and save system partition configurations
  – Set up performance monitoring hierarchies and archives
- ***Centralized Management Interface***

This provides a SMIT-based interface for system management commands, as well as command line equivalents.

- Tools are provided for orderly shutdown and restart of the system.

File Management

Groups of files can be defined as a file collection and any changes to files in that collection are propagated to the appropriate nodes.

Virtual Shared Disk Management

The PSSP components that help you create and manage virtual shared disks are:

- IBM Virtual Shared Disk, the component with which you create and manage virtual shared disks. It has a device driver that operates with the AIX Logical Volume Manager for your applications that use the virtual shared disks.
- Recoverable Virtual Shared Disk, the component that provides recoverability of your virtual shared disks when a node, adapter, or disk failure occurs.
- Hashed Shared Disk, the component that works with the IBM Virtual Shared Disk component to offer data striping for your virtual shared disks.

These components are documented in the book *PSSP: Managing Shared Disks*.

SP User Management

- Commands are supplied to add, change, and delete users and passwords.
- Users can have the same account, home directory, and environment across all nodes in the system.
- The **user.admin** file collection is provided for propagating user administration files to the nodes on the system.

Job Management

As of PSSP 3.1, the SP job management function has been integrated into the IBM LoadLeveler product.

Accounting

Accounting support provides accounting record consolidation and parallel job accounting.

Change Management

- System partitions can be used to apply and test new levels of software.
- Parallel management commands can be used to apply maintenance directly to nodes.
- File collections can be used to propagate changed files to nodes that have the file collection installed.
- For extensive service a new **mksysb** can be created and the nodes reinstalled using NIM.

Communication Subsystem Support

| The Communication Subsystem supports the reliability and performance of the SP
| switch network.

Availability and Problem Management

- Group Services provide a distributed coordination and synchronization service. For more information, see Chapter 25, "The Group Services Subsystem" on page 365.
- Event Management matches information about the state of system resources with information about resource conditions that are of interest to client programs. For more information, see Chapter 26, "The Event Management Subsystem" on page 377.
- Problem Management provides for pairing actions with system events. For more information, see Chapter 27, "Using the Problem Management Subsystem" on page 405.
- A single point of control for configuring, archiving, and maintaining various system logs on individual nodes is provided.
- Additional logs may be specified for use by applications.

SP/Netfinity Server Consolidation

Enables control of a Netfinity server from the control workstation of the SP system, a single point of control for both systems.

Packaging

The PSSP software is packaged as several **installp** images. Each image contains one or more file sets. For complete information on these images and the file sets that each image contains, see the book *PSSP: Installation and Migration Guide* or the *File Set List for PSSP* table in the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.

Other IBM Products

A large number of system and application software products developed by IBM can be run on the SP system. For example:

- IBM LoadLeveler

  Distributed, network-wide job management with parallel batch jobs a specialty
- IBM Parallel Environment for AIX

  Parallel application development and execution

  Message passing parallel task communications
- IBM Engineering and Scientific Subroutine Library for AIX (ESSL)

  Library of subroutines for use by applications
- IBM Parallel Engineering and Scientific Subroutine Library for AIX (Parallel ESSL)

  Set of advanced parallel subroutines which extend the ESSL product
- IBM High Availability Cluster Multi-Processing for AIX (HACMP)

  Ensures that critical resources are available for processing

- IBM Network Tape Access and Control System for AIX (NetTAPE) and IBM NetTAPE Tape Library Connection for AIX

  Simplifies tape access and operations management in SP systems

- IBM Client Input Output/Sockets for AIX (CLIO/S)

  High speed, transparent data transfer and tape access between MVS/ESA systems and AIX systems or between AIX systems

- IBM General Parallel File System for AIX

  Concurrent shared access to files spanning multiple disks located on multiple nodes

- ADSM/6000

  System and user data management

- PTX/6000

  Performance monitoring

- NetView for AIX

  Enterprise network management

- Trouble Ticket for AIX

  Problem management

- PSF/6000

  Printing support

- Job Scheduler for AIX

  Schedules production batch workload in a distributed AIX environment

Independent Software Vendor Products

There is an aggressive program in place to enable and encourage independent software vendors to port their applications to the SP system.

Security on the SP System

Chapter 2. Security Features of the SP System

The goal of this chapter is to present security in the context of a complete computer complex, often extending beyond the bounds of the SP system, and then to explain the SP system-specific support that can fit in with your security policy and implementation. This chapter introduces some terminology, some basic security concepts, and the SP system-specific security concepts.

Computer security is a large topic and there is abundant literature on the subject in the volumes of AIX and DCE publications. Do not rely solely on PSSP publications to fully explain how to implement or administer security on your SP system. The following are required to understand and exploit the security features of the SP system:

1. You must have a clearly expressed and understood security policy for your organization. This includes understanding:
   - The degree of control you require over individuals and groups to access resources and perform activities, and in which SP system partitions.
   - Which authentication services (Distributed Computing Environment (DCE), Kerberos V4, and standard AIX) are to be used to help enforce your security policy.
2. You must already understand security of computer systems and the security services (DCE, Kerberos, and AIX) that your organization does, or intends to, use.
3. You must be familiar with information in other publications that relate to your organizations's security policy and implementation.

Terminology

Before proceeding, you should be familiar with terms in the following list. Some terms apply mostly to Kerberos V4 and others also apply to DCE and Kerberos V5. Some terms, however, might be defined differently in DCE documentation. For a complete understanding of DCE terminology, see the appropriate DCE publication. See “Suggested Reading for using DCE” on page 26 for references.

Access control
The process of limiting access to system resources only to authorized principals.

ACL
Access Control List. A list that defines who has permission to access certain services; that is, for whom a server may perform certain tasks. This is usually a list of principals with the type of access assigned to each.

AFS
A distributed file system that uses Kerberos V4 authentication and includes authentication services that can be used by an SP system.

authentication
The process of validating the identity of either a user of a service or the service itself. The process of a principal proving the authenticity of its identify.

authentication Database
: A set of files containing the names and authentication information of all principals within a realm. An authentication realm has one primary database and may have multiple secondary databases. Secondary databases are backup copies of the primary database and may be provided to improve performance or availability.

authenticator
: An authentication protocol string created each time authentication occurs and sent with the ticket to the server. It contains a time-stamp encrypted in the session key that can reliably show that the authentication request actually came from the client identified in the ticket.

authorization
: (1) The process of obtaining permission to access resources or perform tasks. In SP security services, authorization is based on the principal identifier.(2) The granting of access rights to a principal.

cell
: An independently administered collection of file server and client machines running DCE or AFS. An AFS cell is equivalent to a Kerberos V4 realm.

client
: The user of the shared services of a server. This term can refer to a program (a process requesting a service) or to the person who invoked it. For authentication purposes it is a principal identifier registered in the authentication database.

credentials
: A protocol message, or part thereof, containing a ticket and an authenticator supplied by a client and used by a server to verify the client's identity. The message can contain additional information used by the server to verify its identity to the client.

Data Encryption Standard (DES)
: The secret-key (also known as “private-key”) encryption algorithm that is used by Kerberos V4.

DCE
: The Distributed Computing Environment designed and developed through the Open Group. AIX DCE is an implementation of DCE for RS/6000 systems.

discretionary access control
: A means of restricting access to objects based on the identify of the principal.

domain
: A collection of systems over which an administrator exercises control.

identification
: The process of stating the identity of a principal. No proof of authenticity of the identity is implied.

instance
: A qualifier for a principal name. For services, an instance represents a particular occurrence of the server. For users, an instance allows a single user to assume additional (or alternate) roles with different authority.

Kerberos

A service for authenticating users in a distributed environment by providing mutual authentication of two principals using a trusted third party.

Kerberos V4

Version 4 of the Kerberos authentication service from the Massachusetts Institute of Technology (MIT). The use of some implementation of Kerberos V4 is required in pre-PSSP 3.2 nodes for authentication within some SP administrative services. An SP implementation of Kerberos V4 is provided with PSSP.

Kerberos V5

Version 5 of the Kerberos authentication method from MIT. Kerberos V5 is not protocol-compatible with earlier versions of Kerberos. Kerberos V5 is used as the basis of distributed service authentication within DCE.

key

A value used to encrypt protocol strings used for authentication. The private keys of principals are stored in the authentication database. Session keys are contained (encrypted) in tickets and other protocol strings.

key management

The process of periodically changing the key associated with the DCE principal of a server in order to prevent the key from expiring and thereby disabling the server.

Kerberos V4 master key

The key derived from the Kerberos V4 Master Password supplied initially by the administrator when the primary SP authentication server is created. This key is saved in the **/.k** file which the Kerberos V4 daemons read instead of prompting for a password. It can also be read by certain database utility commands for the same purpose.

Kerberos V4 master password

The password the administrator supplies when initializing the primary authentication server.

mutual authentication

the process of two principals proving their identities to each other.

object

an entity that contains or receives information. Access to an object potentially implies access to the information it contains. Examples of objects are: files, jobs, queues, nodes, services, and users.

per-node key management

The process of providing key management on each node in an SP system.

principal

An entity whose identifier and key are maintained in the authentication database. A principal can represent a user, an instance of a service, or an instance of trusted client code whose identity is to be authenticated.

realm

A domain which shares an authentication database and servers. There is a single name-space for principal name/instance pairs within a realm.

A realm is also a logical collection of clients and servers registered in the database.

security policy
The set of rules, established by an organization's management, that determines how a system manages, protects, and distributes sensitive information and access to its resources.

server
A functional unit (usually a daemon program and child processes) running on a particular host that provides shared services to users over a network. A process providing a service.

service
The name of a principal whose identity is assumed by a server for purposes of authentication. Multiple servers can use the same service name.

server key file
(Also referred to as a **srvtab**) A file containing the names and private keys of the local instances of services. It is accessible only to processes that run under the UID of the user owning the server daemons. On an SP system, all services run as root.

session key
A temporary key supplied by an authentication server to clients and servers, that is used to encrypt parts of authentication protocol messages. Its lifetime is the same as the ticket with which it is created.

trusted service
A service which is responsible for enforcing some part of the security policy of the system.

ticket
An encrypted protocol message used to pass the identity of a user from a client to a server. Tickets are created by the Kerberos V4 authentication server and cached in disk files on the client's system.

ticket-granting-ticket
The initial ticket obtained by a user. It is used by client programs to obtain additional tickets for authentication with application services.

Basic Security Concepts

Security is provided on the SP system, not by some independent means, but by having a comprehensive security policy enforced by a combination of the following:

- Trusted people.
- Cooperative software services which can be trusted to enforce security.
- Some degree of physical security.

With respect to security, the SP system is basically a cluster of RS/6000 workstations connected on one or more LANs, with the control workstation serving as a central point to monitor and control the system. The SP system is exposed to the same security threats as any other cluster of workstations connected to a LAN. The control workstation, as the single point of control, is of particular concern. If security is compromised there, the entire system is effected.

In today's distributed environments, many autonomous computing systems are interacting. They are often connected through an unreliable (in terms of security) network, which is used for remote login or command execution, remote data access, and for remote management. Each of these computers might have its own administrator and its own user database and file space. The services they offer are often based on the client-server model. The SP system participates in such an environment.

Distributed Client-Server Environments

Distributed client-server environments represent a way to quickly and transparently deliver information to users from various sources and locations. This technology can help companies reduce cost and time as well as improve quality and customer satisfaction. The client-server model implies cooperative and distributed processing and relies on a message-based communication between a requester (or client) that asks for a specific service and a responder (or a server) that provides the information. The message exchange can be synchronous or asynchronous.

The most basic form of client-server computing has only two pieces: a client process and a server process connected through a network. The server process is the provider of services and the client is the consumer or requester of services. Clients usually manage the user interface portion of the application, while server programs generally receive requests from client programs, execute the specified action, and dispatch the response to the clients. The client software component requests a service on behalf of the user, like a login request, access to a remote file, or an action to be performed on an object. The server, which often runs on a different machine, processes that request after checking the client's identity and permissions, in other words, after authenticating the client.

Authentication on the SP System

Administering an SP system from a single point of control requires the use of administrative applications that are based upon the client-server programming model. Typically, a client-side command line or graphical user interface is used to perform an administrative task on one or more network-attached nodes or workstations, in parallel or serially. Where privileged applications such as these communicate across networks, security can be compromised unless a reliable means is used to restrict access to authorized users. Accomplishing this authorization first requires authentication, which is the validation of the identities of client and server. Authentication is also the foundation for providing other security features such as accountability, discretionary access controls, and least privilege.

An SP system implementation, for example, can consist of SP nodes with internet connections, a control workstation, and connections to other clustered workstations. Any of these system elements can be vulnerable to a security compromise. All networked services, as well as clients who may need to provide sensitive data to services, must be able to restrict access to those services according to a meaningful security policy. Such access restrictions can be successful only by the reliable authentication of the identities of clients and servers.

There are primarily two facets of security that an administrator addresses:

1. Keeping non-authorized individuals from accessing any part of the system.
2. Ensuring that even authorized individuals access only those resources for which they have further specific authorization.

In order to address these two facets of security, you need to understand the different levels of security.

The first level of security is ***identifying*** the individual or client attempting to access your system. The second level involves ***authenticating*** the individual, usually by using an ID and password. The third level of security involves ***authorizing*** an individual or client to access certain parts of the system for which they have authorization. Each of these levels involve information having to pass certain checks involving criteria that can differ with the authentication method in effect:

- Identification. The identity of the user is presented, for example a user name, numeric user ID (UID), or principal.
- Authentication. Some kind of credentials are provided to prove this identity. Authentication can be based on a personal password, or, in the case of a trusted service, a key.
- Authorization. The permissions of the client to perform the requested action are checked. The record of authorizations and their management can differ depending on the desired action. For example:
  - File access can be protected through UNIX mode bits.
  - Login authorization is typically controlled by the user database that stores the password, which in this case is the authentication information.
  - SP resources, like hardware objects, and the performance of certain tasks on the SP are protected by SP trusted services using key management and your choice of authentication methods. Authorization can be based on principal identity, group membership, or ACLs.

Apart from the fact that most security exposures are still caused by poorly chosen passwords, the insecure network introduces several new security threats. Both partners of a client-server connection might be impersonated, that is, another party might pretend to be either the client (user) or the server. Connections over the network can be easily monitored and unencrypted data can be stored and reused. This includes capturing and replaying of user passwords or other credentials, which are sent during the setup of such client-server connections.

A common way to prevent impersonation and ensure the integrity of the data that is transferred between client and server is to set up a trusted third party system, which provides authentication services and optionally, encrypts all the communications to allow secure communication over the physically insecure network. A popular system which serves this task is Kerberos, an authentication method designed and developed by the Massachusetts Institute of Technology (MIT).

With PSSP 3.2, you have the option to choose which security services are to be used on your SP system for authentication by:

- The remote commands (**rsh**, **rcp**, **rlogin**, **telnet**, and **ftp**).
- The Sysctl remote command execution facility, the System Data Repository, the hardware monitor, and other components that protect SP system objects and are categorized as *SP trusted services*.

For each SP system partition, you can choose to use the new PSSP support of DCE, the continuing PSSP support of Kerberos V4, or the standard AIX authentication service. You must use at least one authentication method for remote commands while you can choose not to use authentication for SP trusted services if you consider your environment secure enough anyway. The administrator can specify the following:

1. The authentication service to be installed and configured (DCE, Kerberos V4 , either, both, or none). Standard AIX authentication can be used in any case but does not need to be specified.
2. The authorization files to be created for the remote commands (/.k5login for DCE, /.klogin for Kerberos V4, /.rhosts for AIX). At least one is required for remote commands to work.
3. The authentication methods to be enabled for use with AIX remote commands (DCE, Kerberos V4, standard AIX). At least one is required for remote commands to work.
4. The authentication methods to be enabled for use in SP trusted services (DCE, compatibility, either, both, or none).

Selecting the *compatibility* authentication method means that each SP trusted service is free to operate as it did before PSSP 3.2. Services which used ACL, Kerberos V4, and AIX authentication, or no authentication will continue doing that.

When determining which authentication method to use for remote commands, AIX examines the order of precedence set by the AIX **chauthent** command. This order determines which authentication method is used when the remote commands are issued on the workstation. This means that if the first method fails authorization, the second method is tried, and so on. The order of precedence, defined as being from the highest level of security to the lowest level of security, is Kerberos V5, Kerberos V4, then Standard AIX.

The PSSP software includes two types of administrative programs that benefit from these security features:

- Applications that manage the resources of the SP system.
- Applications that provide secure remote execution of SP administration commands. These include support for delegation of root user tasks to other users without distributing root's password.

SP Trusted Services

Security is achieved through PSSP services being trusted to correctly enforce the security policies of the SP system in cooperation with the enabled authentication methods. Each service which provides access to the system or to any operation or information in the system is responsible for enforcing the security policy as it applies to the objects for which it is responsible. Such services are called SP trusted services. They each have a service principal for DCE and a key with an encryption mechanism.

Each SP trusted service defines and enforces a discretionary access control policy: PSSP does not support mandatory access controls or integrity controls. A discretionary access control policy is one that allows the owner of an object (or some appropriately authorized user) to determine the type of access to the object that may be granted to other users.

Trusted services authenticate clients and each other, based on the authentication methods enabled by the administrator, according to the following convention:

- When **DCE** is the only authentication method enabled, SP trusted services use DCE authentication.
- When **compatibility** is the only authentication method enabled, each SP trusted service uses whichever authentication methods it used in earlier releases, such as Kerberos V4, standard AIX authentication, or authentication mechanisms implemented by the service itself. If it used no authentication method then it continues to provide unauthenticated services, thereby being compatible with earlier releases.
- When both **DCE and compatibility** are enabled as authentication methods, SP trusted services are free to use the new and the old methods. Authentication is attempted first using DCE and if it does not succeed, the compatibility method is used.
- When **no authentication** methods are enabled, SP trusted services that are critical to installation, administration, and operation of the SP system still function correctly, using the security measures which have been and still are inherent in them, if any, such as client must be root or must be authorized by an ACL.
- If a server cannot reliably determine the set of authentication methods or that no authentication methods are enabled in the SP system partition, it rejects requests until it can. This can happen, for instance, if a resource is not available.

The PSSP components and the SP trusted services enforce security as applicable to their environment. While the environment is common to most SP services and allows them to enforce security in a common manner, some PSSP components or SP trusted services might have an environment that causes them to enforce security by different means. For instance, LoadLeveler and the RSCT software can run on systems without PSSP, so they use different means to enforce security, but they are still SP trusted services.

Most interaction with SP trusted services is internal but often through user interfaces such as SP Perspectives, SMIT, or commands. As a result, there are cases when individual users need to be directly authorized to use a service, while in other cases individual users need only be authorized to use the PSSP component which uses the SP trusted services.

Table 1 lists the SP trusted service and the type of authentication it does depending on the authentication enabled and the PSSP release level.

Table 1 (Page 1 of 2). SP Trusted Services

	Authentication Methods	
SP trusted service	**PSSP 3.2**	**Pre-PSSP 3.2**
Communication Subsystem (CSS)	Client is root	Client is root
Dynamic Probe Class Library	DCE and compatibility	AIX user ID and group ID with CDMF encryption
Event Management	Uses RMS for service communication, DCE or compatibility for clients	Uses RMS for service communication, none for clients

Table 1 (Page 2 of 2). SP Trusted Services

	Authentication Methods	
SP trusted service	**PSSP 3.2**	**Pre-PSSP 3.2**
General Parallel File System	DCE and compatibility	None
Group Services	Uses RMS and client is root or member of AIX group hagsuser	Uses RMS and client is root or member of AIX group hagsuser
Hardware Monitor - hardmon	DCE ACL and compatibility	Kerberos V4 ACL, or none but client is root
LoadLeveler	DCE **or** compatibility, plus rsh authority and connectivity to LoadL scheduler	connectivity to LoadL, CDMF encryption, AFS credentials or DCE credentials, valid ID on node.
Parallel Environment	DCE and compatibility	rsh/rcp authority on node
Problem Management	DCE and compatibility	Kerberos V4 principal or AIX user ID with sysctl authority to initiate processes
Reliable Message Service (RMS) for UDP/IP messages	Authentication provided by topology services	Authentication provided by topology services
Switch Table Services	DCE and compatibility	Client is root
Sysctl	DCE ACL and compatibility	Kerberos V4 ACL, or none but client in sysctl ACL
System Data Repository	None for reads, otherwise DCE and compatibility	None for reads, otherwise client is root
Topology Services	DCE key file and compatibility	None but client is root

Concepts Specific to DCE

This section provides some conceptual information regarding the distributed computing environment (DCE) security services. If you need more information, see “Suggested Reading for using DCE” on page 26 for references.

The DCE security services can be used in the SP environment for authentication by SP trusted services. AIX 4.3.1 and later releases provide AIX authenticated remote commands which support Kerberos V5 authentication. Kerberos V5 is an authentication method that you can use through a protocol provided by the DCE security services. Kerberos V5 can be used in the SP environment for authentication during AIX remote command processing.

Overview of DCE

DCE has established a standard in the client-server arena that is available on all IBM operating systems or platforms, such as AIX, OS2, MVS, VM, and OS/400. It is also available on competitor platforms. DCE takes complete advantage of the client-server paradigm. It offers a set of services and APIs that you can use to build distributed applications and a set of management tools to manage the distributed environment. It can also interoperate with other environments. Some of the benefits provided by DCE are:

- Support of Distributed Applications

  DCE provides a high-level, coherent environment for developing and running applications on a distributed system. DCE components fall into two categories; tools for developing distributed applications and services for running distributed applications.

  The tools, such as Remote Procedure Call and Threads, assist in the development of an application.

  The services, such as the Directory Service, Security Service, and Time Service, provide the services required in a distributed system. These are somewhat similar to some of the services that an operating system provides in a centralized system.

  The components and services provided for the application programmer and the system administrator perform many of the tasks that used to require their own code. With DCE, application programmers do not need to write explicit code that handles the network communications between machines or between distributed applications.

- DCE Services are Integrated and Comprehensive

  In addition to providing all the tools and services needed for developing and running distributed applications, DCE components themselves are well integrated. Because many of the DCE components are themselves distributed applications, they use each other's services whenever possible. DCE not only supports the development of distributed applications, but also includes services that address some of the new problems inherent in the distributed system itself, such as data consistency and clock synchronization. DCE includes management tools for administering all of the services and many aspects of the distributed environment itself.

- DCE Provides Interoperability and Portability Across Heterogeneous Platforms

  By design, DCE is oriented toward heterogeneous rather than homogeneous systems. The DCE architecture allows for different operating systems and hardware platforms. Using DCE, a process running on one workstation can interoperate with a process on a second workstation, even when the two have different hardware or operating systems. Therefore, DCE accommodates a wider range of networks, especially networks needing distributed computing for the historical reasons previously listed. Moreover, applications built using DCE are portable to other hardware or operating system platforms that run DCE.

- DCE Support Data Sharing

  Another benefit is support of data sharing through the directory service and distributed file service. A user anywhere in the distributed system can share data by placing it in the name space or in a file, whichever is appropriate for the application. The data is then accessible by authorized users throughout the system.

- DCE Participates in a Global Computing Environment

  DCE interacts with the outside world. In addition to supporting cooperation within and between systems, DCE systems can also interoperate with computing environments outside of DCE. In particular, the DCE Directory Service can interoperate with two standard, global directory services (X.500 and Domain Name Service), which allow users from within DCE to access information about the outside world. In this way, DCE participates in a global directory service. One benefit of such participation can be seen in the DCE distributed file system which looks like one global file system and users anywhere in the world can address the same file using the same global name.

DCE Security Services

Distributed computing encourages a free flow of data between nodes, thereby expanding the capabilities of interconnectivity and interoperability. The DCE Security Service is a building block of the DCE core services based on Kerberos technology that provides secure authentication, authorization, and auditing mechanisms for users and distributed client-server applications. For data encryption, DCE uses either Data Encryption Standard (DES) or the Common Data Masking Facility (CDMF). CDMF works with a 40–bit encryption key in contrast to the 52–bit DES key. CDMF is allowed to be exported from the USA, whereas DES underlies certain export restrictions.

Developers can use DCE Security Service to make their distributed client-server applications or products secure. Most of the DCE security is related to the concept of a principal. A principal is an entity that can be authenticated and can engage in trusted communication. A principal usually represents a user, a network service, a particular host, or a cell. The services that make up the security component are:

- Registry Service (RS) — a replicated service that maintains the cell's security database. This database contains entries for accounts, principals, groups, organizations, and administrative policies.
- Authentication Service (AS) — used to verify the identify of principals. It contains a ticket-granting service that grants tickets to these principals and services so they can engage in secure communication.
- Privilege Service (PS) — certifies a principal's credentials that are going to be forwarded in a secure way to DCE servers. The credentials allow the target server to check the principal's access rights to resources.

DCE Entities used by SP Security Services

For most SP trusted services, access control is based on membership in DCE groups. To manage access, the DCE security administrator adds or removes principal names from each group. The DCE entities used by SP security services are provided by default but can be locally overridden in your installation.

Note: If local overrides have been made to any DCE entities, be sure to use the names locally placed in the **spsec_overrides** file in place of the corresponding default names used in this book.

Understanding Access Groups for SP Trusted Services

The SP security services configuration files define these SP DCE groups using default names that you can override. There are three types of groups, each with a different purpose:

1. A ***control*** group.

   This group controls access to the ACL of all SP security objects. It is used by services that manage DCE ACLs, which are currently the SP system monitor (hardmon) and Sysctl. It is also needed to create the key file for Topology Services. The default name is **spsec_admin**. During SP configuration processing to set up DCE, the principal name **cell_admin** is automatically added to the **spsec_admin** group. As an authorized administrator using the **cell_admin** principal, you can add more principals to this group for others who are to be security administrators for SP objects. You can also add more group entries to SP ACLs. Do not change any automatically generated ACL entries.

   There is an SP ACL management component of PSSP. Your interface to SP ACL management includes the **spacl** command and the **spauth_spacl** SMIT fast path.

2. A ***user access*** group.

   User access groups give their members access to SP security objects, allowing members to perform administrative tasks using commands or graphical user interfaces. Some user access groups are defined by default. These groups generally have no members by default, though some might. As the security administrator, you add user principals as members of user access groups according to the security policy of your organization. You can add, change, or delete principals as members, using the standard DCE interface for those actions whenever you need to.

   For a list of each group and its purpose, see Table 2 on page 49.

3. A ***service access*** group.

   Members of groups of this type are SP trusted services which are given access to other SP trusted services and their objects. Members are principals that are created by default for and managed by SP trusted services. Administrators are not to change, add, or delete service access group or principal names.

Understanding the Naming Convention for Access Groups

SP trusted services generally implement access controls by granting privileges to one or more groups when using DCE authentication. These access groups are created at configuration time as defined at installation time by the **spsec_defaults** and **spsec_overrides** files. There is no pre-defined format for group names.

Understanding the Naming Convention for Principals

Within the local cell, a server that has a separate instance for each SP system partition uses a principal name of the form:

principal = *package*/*partition*/*service*

Within the local cell, a server that has a single instance uses a principal name of the form:

package/*DCEhostname*/*service*

where:

principal is the derived principal name.

package is the name of the installed software component. It is the first element, such as ssp, ppe, and rsct, from the SERVICE entries in the **/spdata/sys1/spec/spsec_overrides** file.

partition is the syspar name by which an SP system partition is known.

DCEhostname is the name assigned when DCE was installed and configured on the server host.

service is the second element, such as sdr, hardmon, and hats, from the SERVICE entries in the **/spdata/sys1/spec/spsec_overrides** file.

For example, **ssp/part4/sdr** would be the principal name used by the instance of the **sdr** server in the SP system partition named **part4** which was installed from the **ssp** package. The principal name **LoadL/master.xyz.org/Schedd** is an example of one used by the **Schedd** server, installed from the **LoadL** file set, that serves all system partitions from a host with the DCE host name **master.xyz.org**.

Understanding the Naming Convention for Keytab Objects and Files

Keytab objects and files are created using the **create_keyfiles** command. They are used by daemons and service clients to log in to DCE. The name of a given object and file is the same as that of the service principal for which it is created. The name is derived from the principal name used by the service. The path name for a keytab file is derived using the **/spdata/sys1/keyfile/***principal*. For example, the previous example **sdr** server would use the **/spdata/sys1/keyfile/ssp/part4/sdr** keytab file.

Keytab files can also be created by users in order to run jobs such as **cron** which use trusted service client interfaces from scripts running in the background. This kind of keytab file contains the user's key, the encrypted DCE password, rather than the key for a service principal. The user's background script specifies the file when invoking the **dsrvtgt** command. This keytab file can have any path name but it must be accessible only by the owner of the UID running the command and the client interfaces.

Understanding the Naming Convention for CDS Paths

Entries in the Cell Directory Service (CDS) database are required for servers that use DCE ACLs to locate the servers that own objects protected by ACLs. The CDS is a tree-structured database with *directory* objects for branches and *rpcentry* objects for leaf nodes. The CDS path to a server will have the form:

/.:/subsys/*principal*

where

principal is the principal name derived as previously described and used by the server.

In the CDS naming convention **/.:/subsys/***package* and **/.:/subsys/***package*/*DCEhostname* are names of directory objects. Each server (ACL manager) is represented by an rpcentry object with a path name like **/.:/subsys/***package/DCEhostname/service*.

To an administrator using DCE ACL management interfaces, each object (and its ACL) is known by a CDS path name that consists of the local cell, the subsystem path for the particular server instance, and the *residual name* of the object. The residual name is all that is used by the server locally in its ACL database operations. To illustrate DCE object naming, consider a frame object owned by the hardware monitor running on the CWS with the DCE hostname **cws3.xyz.com**. To derive the CDS path name, the following happens:

- The hardware monitor daemon creates the object **frame2/slot1** which is the residual name.
- When manipulating the ACL for the object, an administrator (member of the **spsec-admin** group) uses either the SMIT or the command-line interface. Those interfaces access the object through the CDS path name **/.:/subsys/ssp/cws3.xyz.com/hardmon/frame2/slot1** for this example.

Suggested Reading for using DCE

You can find these and other DCE publications from the Web address http://www-4.ibm.com/software/network/dce/library

- *IBM DCE Version 3.1 for AIX: Release Notes* contains last minute information that could not be included in other documents
- *IBM DCE Version 3.1 for AIX: Quick Beginnings* describes DCE and explains how to plan for, install, and configure the product.
- *IBM DCE Version 3.1 for AIX: Introduction to Distributed Computing Environment* provides an overview of DCE and serves as an introduction to the rest of the DCE documentation. It also contains a glossary of terms used in the DCE documentation.
- *IBM DCE Version 3.1 for AIX: Administration Guide–Introduction* provides conceptual and task-oriented information for the DCE administrator. The first part is an introduction to DCE administration. The second part explains configuring and starting up DCE.
- *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components* provides concepts and procedures. Describes the core components of DCE and how to use them.
- *DCE Version 3.1 for AIX: Administration Commands Reference* provides reference material for DCE commands, including administrative commands.
- *DCE Version 3.1 for AIX: Problem Determination Guide* lists error messages and recovery actions along with administrative tips.
- *IBM DCE Version 3.1 for AIX: Application Development Guide–Introduction and Style Guide* provides information for the distributed application programmer. It provides conceptual and task-oriented information for developing an application using DCE and describes programming with DCE in general, using various components and facilities.
- *IBM DCE Version 3.1 for AIX: Application Development Guide–Core Components* describes the APIs for the various DCE components.
- *IBM DCE Version 3.1 for AIX: Application Development Guide–Directory Services* describes the DCE naming and access to CDS through XDS, the use of the X/Open Directory Service Interface, and the Object Classification Tables and other information on XDS, X500 Directory, and GDS objects.

- *IBM DCE Version 3.1 for AIX: Application Development Reference* provides reference material for the DCE programming interfaces and has command references for commands needed by the DCE programmer.

Concepts Specific to Kerberos V4

This section provides detailed conceptual information regarding Kerberos V4. Some of the information might also apply, in a general sense, to DCE and Kerberos V5. For conceptual information regarding DCE specifically, see the appropriate DCE documentation.

Kerberos V4 uses a server to achieve mutual authentication between a client and a server in a client-server environment.

Kerberos V4 Components

In general, Kerberos V4 consists of systems, objects, tickets, and keys.

Systems

The systems that make up a Kerberos V4 environment include a:

- Client which makes a request to the server
- Server which provides service to the client's request
- Server which provides authentication information for both the client and the server.

Objects

The objects that make up the Kerberos V4 environment include principals, instances, realms, tickets, and keys:

Principals

Kerberos V4 principals are either users who use authentication services to run the Kerberos V4-authenticated applications supplied with the SP system or the individual instances of the servers that run on SP nodes, the control workstation, and on other IBM RS/6000 workstations that have network connections to the SP system.

User Principals for SP System Management – An implementation of the SP system must have at least one user principal defined. This user is the authentication database administrator, who must be defined first so that other principals can be added later. When AFS authentication servers are being used, the AFS administrator ID already exists when the SP authentication services are initialized. When PSSP authentication servers are being used, one of the steps included in setting up the authentication services is the creation of a principal whose identifier includes the **admin** instance. It is suggested, but not essential, that the first authentication administrator also be the root user. Various installation tasks performed by root, or other users with UID 0, require the Kerberos V4 authority to add service principals to the authentication database. At sometime prior to invoking the **setup_server** command to complete setup of the control workstation and boot server nodes, a user with UID 0 must be defined as a Kerberos V4 database administrator with authority to add other principals. This is because the service principals used by Kerberos V4-authenticated applications are all defined automatically by **setup_server** during installation and customization.

Apart from this installation requirement, you may use other user principal identities to perform system administration (and authentication administration) tasks.

Service Principals Used by PSSP Components – Two service names are used by the Kerberos V4-authenticated applications in an SP system:

1. **hardmon**, used by the Hardware Monitor daemon on the control workstation and by logging daemons
2. **rcmd**, used by **sysctl**

By convention, a Kerberos V4 server runs as a Kerberos V4 principal whose identifier is formed from the service name and the short host name of the node on which the server runs, converted to lowercase. Different principal identifiers thus indicate the target network address of the different providers of each service. The authentication support in the SP system expands the Kerberos V4 implementation to support workstations with multiple network interfaces as servers. This provides instances for all network interfaces rather than just the standard host name. Kerberos V4 works with the resolved network names, rather than any aliases you might use locally on your hosts.

The **hardmon** daemon runs only on the control workstation. The SP logging daemon, **splogd**, can run on other IBM RS/6000 workstations. Therefore, for each (short) network interface name on these workstations, a service principal is created with the name **hardmon** and the network name as the instance.

The remote commands can be run from, or to, any IBM RS/6000 host on which the SP system authenticated client services (**ssp.clients**) are installed. Therefore, for each (short) network interface name on all SP nodes, the control workstation, and other client systems, a service principal is created with the name **rcmd** and the network name as the instance.

Instances

Instances can be on a client machine or on a server machine. An instance on a client machine is defined as the level of authorization the principal user has. An instance on a server machine is defined as the hostname of the server machine. Kerberos V4 uses the following notation to refer to principals and instances:

```
principal.instance
```

Realms

The authentication realm is the set of systems that is served by a single logical authentication database. A realm can include any combination of one or more SP systems, IBM RS/6000 workstations, and other systems/workstations. The authentication database for a realm is administered as a single entity: principals are defined across the systems within a realm and principal identifiers must be unique within a realm.

There are options for defining authentication realms within a network of systems:

- Each system may be its own realm
- A single realm may include all of the systems in a network
- Systems may be grouped into realms with multiple realms occurring within a network

Generally, systems that are administered together, or by the same set of administrators, should be grouped into a single authentication realm. For example, one or more SP systems and their associated workstations could form a single authentication realm. Within an SP system, all SP nodes are automatically added to the control workstation's local realm during installation.

If multiple realms are configured within a network, the realm names should be unique. During setup of the SP authentication services, the name of the realm defaults to the local system's network domain name converted to uppercase. If a different realm name is going to be used, the local system's realm name must be supplied by the administrator in the **/etc/krb.conf** file. For information on the format of this file, see the *PSSP: Command and Technical Reference*.

If you are using AFS authentication servers, the entire SP system must be in the same cell. The authentication realm known to the SP authentication services is the local AFS cell. The realm name is set to the AFS cell name converted to uppercase.

Although a realm is served by a single logical authentication database, multiple copies of the database may exist on different workstations within a realm. One must be the primary database in a realm; others are secondary servers.

Tickets

Kerberos V4 tickets are encrypted byte strings returned to clients by an authentication server. Tickets contain the client principal's identifier, a time-stamp and ticket lifetime used to determine the expiration time, the session key, and other information, all encrypted in the private key of the service instance with whom the client wishes to authenticate. The client cannot understand the key; it simply forwards it to the service with an authenticator in an internet protocol packet, using either UDP or TCP socket communications. In the case of a ticket-granting-ticket, that service is the Ticket Granting Service provided by the **kerberos** daemon. Other tickets are service-tickets, encrypted in the private key of one particular instance of an application service.

- Ticket-granting-ticket

  Obtained by the **k4init** or **rcmdtgt** command, which saves it by creating the current ticket cache file, over-writing one that already exists. As long as the current ticket cache file contains an unexpired ticket-granting-ticket, the owner of the file can invoke application client programs that require Kerberos V4 credentials.

- Service-ticket

  Obtained by an application client, such as the **sysctl** command, which adds it to the current ticket cache file. As long as the current ticket cache file contains an unexpired ticket for a particular service instance, it can be used by any process that runs under the UID of the file owner to submit requests to that service instance.

Ticket Cache Files: The caching of tickets takes place automatically in disk files on the client system that is the workstation or SP node on which the client user is logged in. These files are created with UNIX permissions set so they can be accessed only by the owner, for they contain sensitive information. Any process using the tickets can authenticate as the owner of the file.

A user can have tickets cached in any number of files simultaneously, and may have reason to do so. If you have multiple logins, run background processes, or use a shared UID, you must do so to avoid destruction of tickets still in use by other processes. This is accomplished by setting the KRBTKFILE environment variable to the path name of a unique ticket cache file prior to using authentication services for each login session or background process. If you do not set KRBTKFILE, then your tickets will be cached in your default file: **/tmp/tkt***uid*.

The first ticket stored in the file is always the ticket-granting-ticket. The file is created by the **k4init**, **ksrvtgt**, or **rcmdtgt** command; and when the TGT is stored, all previously issued tickets in the file are deleted. The file contains, in addition to the TGT, any number of other tickets for application services. There will be one for each service instance with which you have communicated using that particular current ticket cache file. They are obtained by the client commands for the various Kerberos V4-authenticated services, such as **rcp** and **rsh** (and indirectly by SP system administration tools that invoke them).

Kerberos V4 does not automatically delete tickets after they expire. Users must either explicitly destroy their ticket cache files or replace them by re-authenticating (by obtaining a fresh TGT). Tickets are never removed individually from the ticket cache file. The **k4destroy** command eliminates the entire current ticket cache file. Ticket cache files other than the current file are untouched, however.

Ticket-lifetimes: The tickets that you obtain when you issue the **k4init** command are valid only for a limited time. The same limit applies also to service tickets obtained by client programs that you execute. In most circumstances, you probably will not be concerned about how this limit is determined and applied. However, when you run **k4init**, you have the option of requesting a ticket with a specific lifetime. The maximum lifetime you may specify, which is also the default value, was assigned when your principal was registered in the authentication database, or it was changed subsequently by the database administrator. The minimum ticket lifetime is five minutes; the maximum lifetime can be set to one of several discrete values from five minutes to thirty days. The ticket lifetimes of service tickets are always the same as the lifetime of the ticket-granting-ticket used to obtain them. It is the TGT held in the current ticket cache file owned by the user who invokes the application client command.

The external representation of the ticket lifetime is rather inconsistent among the various user and administrator commands. Some commands represent the one-byte ticket lifetime value as a decimal integer between 0 and 255. This is the representation used by the administrator when creating or modifying a principal using the **kdb_edit** command. It is also the format of the ticket life field displayed by the **get** subcommand of **kadmin**. The output of the **k4list** command shows the actual ticket creation and expiration as standard date and time stamps. If you specify **-l** to request a specific ticket lifetime when you run **k4init**, you are prompted to enter the value as a number of minutes. The value you enter is then rounded up to the next higher discrete lifetime interval or the maximum ticket lifetime allowed for your principal, whichever is less, and then mapped to a one-byte value between 1 and 191.

The following table shows the ticket lifetimes that correspond to the encoding used internally by Kerberos V4. The values on the left of each column are the one-byte encoding; on the right, the lifetime interval in days, hours, and minutes.

Ticket lifetimes from 0 to 128 represent multiples of 5 minutes, for example:

```
0-1     00:05   12     01:00   24     02:00   36     03:00   48     04:00
 60     05:00   72     06:00   84     07:00   96     08:00  108     09:00
120     10:00  125     10:25  126     10:30  127     10:35  128     10:40
```

Lifetimes from 129 to 255 represent intervals of from 11:24 to 30 days:

```
129     11:24  130     12:11  131     13:02  132     13:56  133     14:54
134     15:55  135     17:01  136     18:12  137     19:28  138     20:48
139     22:15  140     23:47  141  1d+01:26  142  1d+03:11  143  1d+05:04
144  1d+07:05  145  1d+09:14  146  1d+11:32  147  1d+13:59  148  1d+16:37
149  1d+19:25  150  1d+22:26  151  2d+01:38  152  2d+05:04  153  2d+08:44
154  2d+12:40  155  2d+16:51  156  2d+21:21  157  3d+02:08  158  3d+07:16
159  3d+12:45  160  3d+18:36  161  4d+00:52  162  4d+07:34  163  4d+14:44
164  4d+22:23  165  5d+06:35  166  5d+15:20  167  6d+00:41  168  6d+10:42
169  6d+21:23  170  7d+08:50  171  7d+21:03  172  8d+10:08  173  9d+00:06
174  9d+15:03  175 10d+07:01  176 11d+00:06  177 11d+18:22  178 12d+13:53
179 13d+10:46  180 14d+09:05  181 15d+08:56  182 16d+10:27  183 17d+13:44
184 18d+18:53  185 20d+02:04  186 21d+11:24  187 22d+23:02  188 24d+13:08
189 26d+05:52  190 28d+01:26  191+ 30d
```

Keys

Keys are another Kerberos V4 component. They are similar to passwords in that they are used for encrypting the tickets being sent back and forth between the client and server machines. "Kerberos V4 Authentication" explains how keys are used in the authentication process.

Kerberos V4 Authentication

When this method is active, SP authentication is based on the Kerberos V4 authentication service developed at MIT. SP trusted services use the Kerberos V4 authentication database and server to:

- Initially authenticate the identity of the user.
- Provide the information through which a server can authenticate the identity of a client (user) in a distributed environment.

Kerberos V4 servers function as a trusted third party to authenticate the identities of users and distribute encryption keys to clients and servers, known as *principals*. Every user and every service instance on a particular host is a principal in the Kerberos V4 database. Each Kerberos V4 principal has an identifier, a password, an expiration date, and a maximum ticket lifetime registered in the authentication database. Kerberos V4 does not store the clear-text password, but a 64-bit binary value derived from it using a one-way hash. Database information is also encrypted in the Kerberos V4 master key, known only to the database administrator. Passwords are never sent across the network in clear-text form, neither for user authentication nor during database administration.

Overview of Kerberos V4 Interaction with Client and Server

On the authentication server system there are two daemons that access the database. The **kadmind** daemon provides network access for database administration via the **kpasswd** and **kadmin** commands. The **kerberos** daemon is the actual authentication server. It is sometimes referred to as the "Key Distribution Center (KDC)" because of its role in distributing session keys. The KDC actually consists of two separate functions: the Authentication Service, which generates ticket-granting-tickets based on authentication using the client user's private key;

and the Ticket Granting Service (TGS), which generates service tickets, based on authentication using a ticket-granting-ticket.

The underlying method for accomplishing the authentication is a ticket scheme, consisting of the following steps, illustrated in Figure 1.

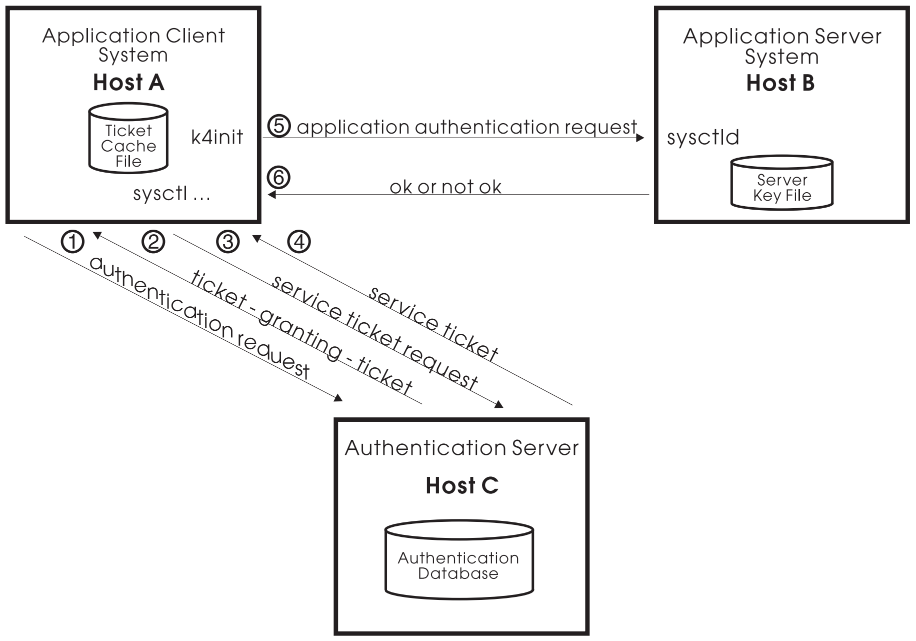


Figure 1. An Overview of Kerberos V4 Authentication

1. The client process, usually as the result of a user invoking the **k4init** command, sends a message to the Authentication Service containing its principal identifier and the identifier of the Ticket Granting Service (a predefined Kerberos V4 principal). This message is not encrypted. The Authentication Service generates a random session key to be shared by the client and the TGS and creates a ticket for the client to use with the Ticket Granting Service. It contains the client identifier and the session key, as well as fields defining the ticket's valid lifetime. The ticket is encrypted in the private key of the Ticket Granting Service. A return message is built, containing the key, the client's identifier, and the ticket-granting-ticket. The Authentication Service encrypts the message in the private key of the user, a one-way hash of the password.
2. The client program reads the user's password and applies the one-way hash necessary to determine the private key. If the password is correct, the key can be used to successfully decrypt the returned message block containing the session key, the client identifier, and the ticket. When successful, the ticket and the session key are stored in the current ticket cache file.
3. The user invokes an application's client interface, which needs to perform authentication on its first network communication with its server. It creates an authenticator, containing the client identifier and a current time-stamp, and encrypts the authenticator using the session key returned with the ticket-granting-ticket. It sends to the Ticket Granting Service a message consisting of the authenticator, the ticket-granting-ticket, and the principal identifier of the service instance which it wants to use. The TGS reads its private key from the authentication database and uses it to decrypt the ticket, obtaining a copy of the session key and the identifier of the client to whom the

ticket-granting-ticket was issued. Using the session key, it decrypts the authenticator. The TGS verifies that the client's identity is the same, and that the authenticator's time stamp indicates that it was very recently created.

4. Like the Authentication Service, the TGS generates a session key, this one to be shared by the client and the application server. It also generates another ticket, called a service ticket, encrypted in the private key of the application service principal. The ticket is returned to the client in a message encrypted with the old session key (shared by the client and the TGS).
5. The client program uses the original session key to decrypt the message. It extracts the new session key and ticket, and saves them in the ticket cache file. When the client program sends its first application protocol message to the application server, it includes the service ticket and a new authenticator, encrypted in the new session key. This session key was also placed in the ticket by the TGS, so the server can retrieve it when it decrypts the service ticket. The application server obtains its private key from the server key file, **/etc/krb-srvtab** on the server system.
6. The authentication by the application server is performed in the same way as by the TGS. The message returned to the client simply indicates success or failure, and an error message number if failure.

The scenario outlined previously assumes no unexpired service ticket was found in the ticket cache file. The ticket-granting-ticket can be used to get as many different tickets as are needed, without requiring the user to reenter the password.

A client's service ticket can be used to re-authenticate as often as the client and server require. Typically, clients using TCP/IP authenticate once on connection to the server. Users of connectionless protocol should authenticate each message exchange, though less rigorous schemes can be used following an initial authentication, by using the shared session key to encrypt a small piece of known data.

Kerberos V4 and DES

The authentication services use the Data Encryption Standard (DES) algorithm. The DES algorithm is used only as an internal method for authenticating the identities of clients and servers. You might need to be aware that in order to comply with U.S. export regulations on the DES algorithm, SP authentication services provide a subset of the full MIT Kerberos V4 services. No interface is provided for using the encryption routines directly. No interface is provided to allow the encryption of any portion of service messages that are not directly connected with the authentication of the client and server identities.

For additional information, see the **Kerberos** man page in the *PSSP: Command and Technical Reference*.

Relationship of PSSP Kerberos V4 and AFS

AFS is a distributed file system developed by Transarc Corporation. AFS includes an authentication implementation that is based on Kerberos V4. Therefore, AFS authentication servers can be used in place of SP authentication servers to provide credentials for SP Kerberos V4 principals.

Although AFS and SP Kerberos V4 authentication services can work together, there are differences in the way the authentication database is administered (for example, adding principals and changing passwords).

AFS uses a different set of servers, protocols, interfaces, and commands for Kerberos V4 database administration.

Understanding AFS Administration

The primary tasks the system administrator performs in administering AFS authentication services are:

- Adding principals (users and services) and setting passwords in the authentication database
- Changing passwords for principals
- Managing the authentication keys for the set of services that use authentication (see "Managing Server Keys For Kerberos V4" on page 67 for more information)

The AFS system has its own administration commands and utilities for the administrator user. These commands and utilities provide for authentication, protection of files, file manipulation, and backup services. The following commands and utilities are relevant for administering authentication services. See the AFS documentation for more information.

afsd	Daemon used to connect AFS clients to AFS server
cacheinfo	Specifies the directory to place the AFS directory on an AFS client
CellServDB	Specifies the name of AFS cell and location of AFS server
kas	Administrator interface to work with AFS authentication
klog.krb	User interface to obtain a Kerberos V4 ticket in addition to AFS tokens
pts	Administrator interface to work with AFS protection services
token.krb	Allows the user to list the current tokens and Kerberos V4 tickets

Understanding How PSSP Interacts with AFS

The following SP authentication services commands work in an AFS authentication system:

- **k4init** (The SP_NAME environment variable must be set in order to use this command on a client workstation, when using AFS authentication)
- **k4list**
- **k4destroy**
- **ksrvutil -afs change**
- **ksrvtgt**
- **rcmdtgt**
- **setup_authent**

The SP authentication services provide only the interfaces from the SP System to work in an AFS authentication system. The SP authentication services do not supply any of the AFS executables.

The AFS system provides multiple daemons that are activated on AFS server machines and support authentication tasks:

bosserver	Basic OverSeer server monitors the AFS server processes on the AFS server machine
kaserver	The AFS authentication server
ptserver	Used to create system entries in the authentication database
buserver	Maintains a backup authentication database on the authentication server

The authentication services work primarily with the **kaserver** and the **ptserver**. The **kaserver** allows the administrator to execute various commands to administer the authentication database. The **admin** user can enter **kas help** to view the commands available. The **admin** user needs to provide a password when using the **kas** command.

The **ptserver** protects and maintains system entries that are stored in the authentication database. The **admin** user can enter **pts help** to view the commands available. The **admin** user needs to provide a password when using the **pts** command. The admin user needs to create an AFS token (**klog.krb**) when working with the **pts** command.

See AFS documentation for information on installing and administering the AFS system.

Chapter 3. Managing and Using SP Security Services

This chapter addresses the tasks that are specific to the security support implemented on the SP system. Other security implementation and administration tasks addressed in AIX and DCE publications are referred to, but are not thoroughly explained. Do not rely solely on PSSP publications to fully explain how to implement or administer security on your SP system. The primary focus in this chapter is to explain the SP system-specific tasks that support your security policy and implementation.

If your SP is not already established with your organization's choice of security implementation or if you are considering changing your security implementation:

1. To prepare for installation or migration and configuration, or for information about choices regarding the security implementations supported on the SP system, see the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.
2. To actually install and configure authentication services, see the book *PSSP: Installation and Migration Guide*.

This chapter explains the tasks involved in on-going management of the security services provided by the PSSP software on the SP system. The main topics included are the following:

- Managing authentication information
- Managing authorization information
- Managing the security configuration
- Managing authentication credentials

The following are prerequisites to performing administrative tasks:

1. You must have a clearly expressed and understood security policy for your organization. You must understand the degree of control you require over individuals and groups to access resources and perform activities, and in which SP system partitions.
2. You must already understand the specific versions of the security services (DCE, Kerberos V4, and AIX) that you intend to use to help enforce your security policy.
3. You must be, or must become, familiar with the information in Chapter 2, “Security Features of the SP System” on page 13 and in other publications that relate to your organizations's security policy and implementation.
4. You need to be authorized to perform the respective security administration tasks.

Enhanced Security Option:

PSSP 3.2 provides the option of running your SP system with an enhanced level of security. This function removes the dependency PSSP has to internally issue **rsh** and **rcp** commands as a root user from a node. When this function is enabled PSSP does not automatically grant authorization for a root user to issue **rsh** and **rcp** commands from a node. If you enable this option some procedures might not work as documented. For example, to run HACMP an administrator must grant the authorizations for a root user to issue **rsh** and **rcp** commands that PSSP would otherwise grant automatically. See the ITSO Redbook *Exploiting RS/6000 SP Security: Keeping it Safe* for a description of this function and a complete list of limitations.

DCE and HACWS restriction:

If you plan to have DCE authentication enabled, you cannot use HACWS. If you already use HACWS, do not enable DCE authentication.

Managing Authentication Information

This section includes the following tasks for managing user's authenticated identities:

- Adding users
- Integrating login with AIX
- Displaying information about users
- Changing user passwords
- Changing user ticket expiration
- Removing users

Adding Users for DCE

See "Creating a New User", "Creating and Maintaining Principals, Groups, and Organizations", and "Creating and Maintaining Accounts" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Adding Users For Kerberos V4

You can add general user principals and Kerberos V4 authentication administrators.

Adding Principals and Assigning Initial Passwords

With PSSP Kerberos V4 Authentication: To add a principal and set the initial password in the Kerberos V4 authentication database, a database administrator with an **admin** principal that is listed in the **admin_acl.add** file can use **kadmin** or **add_principal**.

To use **kadmin**:

1. Enter the **kadmin** command:

   ```
   kadmin
   ```

   A welcome message and explanation of how to ask for help are displayed.

2. Enter the **add_new_key** or **ank** subcommand:

   ```
   ank name[.instance]
   ```

   The only required argument for the subcommand is the principal's name.

3. At the prompt, enter your **admin** password
4. At the prompt, enter the principal's new password
5. At the prompt, reenter the principal's new password.

add_principal operates like **kadmin**, but allows an arbitrarily large number of principals to be added at one time. Whereas **kadmin** always prompts for your administrative password, **add_principal** will use tickets you have already obtained as *login-name*.**admin**. This makes **add_principal** suitable for use in scripts or background processes where a password cannot be provided interactively.

1. Create an ASCII file containing a list of principals and their initial passwords. Make sure it is readable only by you.
2. Enter the **add_principal** command.

   ```
   add_principal filename
   ```

3. Immediately remove the file containing the initial passwords.

The following script fragment shows one way to add a user to the database without interactively editing a file, and keeping the initial password on disk for a minimal amount of time:

```
#( OMASK=$(umask); umask 077; INITIALPW=changeme$RANDOM; \
   print "johndoe $INITIALPW">/tmp/Addp$$; \
   /usr/kerberos/bin/add_principal /tmp/Addp$$; \
   /bin/rm /tmp/Addp$$; umask $OMASK; \
   print "johndoe's initial password is $INITIALPW"; )
johndoe's initial password is changeme28745
#
```

On the system which is the primary Kerberos V4 authentication server, the root user can use the **kdb_edit** command to add principals. The steps are:

1. Enter the command, which operates interactively, prompting for requests.

   ```
   kdb_edit -n
   ```

2. Reply to the prompt for a principal name by entering the user name of the new principal and then the instance.

   ```
   Principal name: joeuser
   Instance:
   ```

3. Reply **y** to confirm that you want to add the principal.
4. Enter the initial password, when prompted.
5. Reenter the password, when prompted.
6. Accept the default expiration date by pressing Enter or type an alternate date in the format shown by the prompt.
7. Accept the default maximum ticket lifetime value or enter another.
8. Press enter when prompted for attributes.
9. The command will respond Edit OK and begin prompting for another principal to add. Repeat the same sequence or press enter to terminate the command.

For a complete example and more information, refer to **kdb_edit** in the book *PSSP: Command and Technical Reference*.

You can use the **mkkp** command to add Kerberos V4 principals to the Kerberos V4 authentication database instead of **kdb_edit**.

When logged into a system that is a Kerberos V4 authentication server, the root user can run the **mkkp** command directly. Additionally, any users who are Kerberos V4 database administrators listed in the **/var/kerberos/database/admin_acl.add** file can invoke this command remotely through a Sysctl procedure of the same name. The administrator need not be logged in on the server host to run **mkkp** through Sysctl, but must have a Kerberos V4 ticket for that **admin** principal (*name*.**admin**).

Like **kdb_edit** (and unlike the **kadmin** command), **mkkp** can set attributes other than the password. Because it is not interactive **mkkp** cannot set an initial password. To complete that step so users can login with the new principals using **k4init**, use the **cpw** subcommand of **kadmin**.

In the following example, these steps are used to add two new principals and then assign passwords to enable Kerberos V4 logins. The Kerberos V4 server host name is **control2**. The user has previously obtained a ticket as *name*.**admin**, for whom an entry exists in the **admin_acl.add** file:

```
$sysctl -h control2 mkkp -e 1998-06-30 jack jill

$kadmin -m

Welcome to the Kerberos Administration Program, version 2
Type "help" if you need it.
admin: cpw jack
Admin password:
New password for jack:
Verifying, please re-enter New password for jack:
Password changed for jack.
admin: cpw jill
New password for jill:
Verifying, please re-enter New password for jill:
Password changed for jill.

admin: quit

Cleaning up and exiting.

$
```

With AFS Authentication: To add a principal and set a password in an AFS authentication database:

1. Enter the **kas** command:

   `kas create -name` *`user`* `[-cell` *`cellname`*`]`

2. At the prompt, enter your AFS password
3. At the prompt, enter the principal's new password
4. At the prompt, reenter the principal's new password to verify

Adding a Kerberos V4 Authentication Administrator

With PSSP Kerberos V4 authentication: To perform the tasks involved in administering SP authentication services, the system administrator must be authorized to do so. The administrator must be a user with an **admin** instance whose name appears on one of the Kerberos V4 authentication administration access control lists (ACLs).

For example, to perform Kerberos V4 authentication administration, the administrator **gail** must have a principal **gail.admin** in the Kerberos V4 authentication database. In addition, **gail.admin** must be in the access control list file for the task she wants to perform. There are three ACL files:

/var/kerberos/database/admin_acl.add
The list of principals authorized to add entries to the Kerberos V4 authentication database

/var/kerberos/database/admin_acl.get
The list of principals authorized to retrieve entries from the Kerberos V4 authentication database

/var/kerberos/database/admin_acl.mod
The list of principals authorized to modify entries in the Kerberos V4 authentication database

Adding a Kerberos V4 authentication database administrator requires two steps:

1. Adding the principal with the **admin** instance, as described previously.
2. Adding the principal identifier to one or more of the ACL files, which must be done by the root user on the primary database system.

With AFS Authentication: AFS administration does not use an **admin** instance or ACL files. You, an AFS administrator, can authorize another AFS user to perform administrative tasks by assigning it the **admin** attribute:

1. Follow the steps described above to add the user, if not already defined.
2. Enter the **kas** command:
   ```
   kas setfields -name user -flags admin [-cell cell]
   ```
3. At the prompt, enter your AFS password

Integrating Login for DCE with AIX

You can limit the impact of SP security features on nonroot users by eliminating their having to log in separately to DCE in order to perform routine tasks. AIX provides software which integrates its login process with that of DCE, if you choose to use it. IBM suggests you do integrate login if you plan on submitting parallel jobs with DCE and the AIX and DCE user ids are different.

See "AIX/DCE Security Integration" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*

Integrating Login For Kerberos V4 with AIX

The system administrator can make using the authenticated services easier for nonroot users by setting up their user accounts so that Kerberos V4 credentials are obtained whenever they log in to the system. Kerberos V4 login cannot take the place of AIX login, but you can automate the process. To set up Kerberos V4 login to run automatically when the user logs in to AIX, do the following:

1. Add a stanza to the **/etc/security/login.cfg** file that names a program that will perform the required **Kinit** processing on the user's behalf. The name of the method (shown in the following example as KERBEROS) can be anything you want. The rest of the stanza should be entered exactly as shown:

   ```
   KERBEROS:
      program = "/usr/bin/ksh /usr/ssp/lpp/kerberos/etc/Kinit"
   ```

2. Use SMIT to update either the **auth1** or **auth2** attribute in the user account for each user you want to use this capability. Add this method after the default **SYSTEM** method in the **auth1** attribute, if you want to require the user to obtain Kerberos V4 credentials in order to successfully login to the system. Specify this method separately in the **auth2** attribute if you want to allow (but not require) the user to obtain Kerberos V4 credentials at AIX login. The *Kerberos V4-principal* must be the user's AIX login name, optionally followed by a period and an instance (for example, **foo** or **foo.admin**). Note the placement of the comma (,) and the semicolon (;) in this syntax.

   The following is an example of an auth1 attribute for AIX user **foo**. When **foo** logs in, the **k4init foo** command is executed after the AIX password for principal **foo**. If **k4init** fails, **foo** is not logged into the system.

   ```
   auth1 = "SYSTEM,KERBEROS;foo"
   ```

   The following is an example of an **auth2** attribute for AIX user **bar**. When **bar** logs in, the **k4init bar.admin** command is executed after the AIX password is validated. The user is prompted for the Kerberos V4 password for **bar.admin**. In this case, if **k4init** fails, **bar** remains logged into the AIX system, but has no Kerberos V4 credentials.

   ```
   auth2 = "KERBEROS;bar.admin"
   ```

Displaying Information about Users for DCE

See "Showing User Information" in the book *IBM DCE 3.1 for AIX: Administration Guide–Core Components*.

Displaying Information about Users For Kerberos V4

This involves the following:

- Listing principals in the Kerberos V4 authentication database.
- Displaying information about principals.

Listing Principals in the Kerberos V4 Authentication Database

With PSSP Kerberos V4 authentication: Use the **lskp** command to list all or some principals in the local Kerberos V4 authentication database. Information displayed for each principal includes the name and instance, the maximum ticket lifetime, the key version number, and the expiration date (local time on the server).

The command allows you to select principals to list in several different ways:

- The entire Kerberos V4 authentication database
- Individual entries by name
- Entries with a specific name
- Entries with a specific instance
- Client (user) principals
- Service principals
- Principals pre-defined by Kerberos V4

The following example lists all principals who are Kerberos V4 administrators plus all instances of the **rcmd** service principal, used by the SP remote commands and the Sysctl facility:

```
#lskp .admin rcmd.

mary.admin tkt-life: 30d key-vers: 3 expires: 2000-12-31 23:59
root.admin tkt-life: 30d key-vers: 5 expires: 2004-05-31 23:59
rcmd.cwsta tkt-life: Unlimited key-vers: 1 expires: 2037-12-31 23:59
rcmd.node1 tkt-life: Unlimited key-vers: 1 expires: 2037-12-31 23:59
rcmd.node2 tkt-life: Unlimited key-vers: 1 expires: 2037-12-31 23:59
rcmd.node3 tkt-life: Unlimited key-vers: 1 expires: 2037-12-31 23:59

#
```

When logged into a system that is a Kerberos V4 authentication server, the root user can run the **lskp** command directly. Additionally, any users who are Kerberos V4 database administrators listed in the **/var/kerberos/database/admin_acl.get** file can invoke this command remotely through a Sysctl procedure of the same name. The administrator need not be logged in on the server host to run **lskp** through Sysctl, but must have a Kerberos V4 ticket for that **admin** principal (*name*.**admin**).

In the following example, **control2** is the Kerberos V4 server host name. The user has previously obtained a ticket as *name*.**admin**, for whom an entry exists in the **admin_acl.get** file:

```
$sysctl -h control2 lskp default

default tkt-life: 30d key-vers: 1 expires: 2037-12-31 23:59

$
```

For more information, see **lskp** in the book *PSSP: Command and Technical Reference*.

With AFS Authentication: To list the authentication database information, an AFS administrator uses the **kas list** command. It lists all entries in the database. For example (other entries have similar format):

```
$kas list -l -admin_user afsadm

Administrator's (afsadm) Password:
User data for afsadm (ADMIN)
   key (0) cksum is 1479418564, last cpw: no date
   entry never expires. Max ticket lifetime 720.00 hours.
   last mod on Fri Jun 28 09:12:56 1996 by afsadm
User data for joseph
   key (0) cksum is 1852746310, last cpw: Mon Mar 25 14:45:00 1996
   entry never expires. Max ticket lifetime 720.00 hours.
   last mod on Fri Jun 28 09:15:09 1996 by afsadm
...

$
```

Displaying Information about Principals

With PSSP Kerberos V4 authentication: There are two ways for to examine information about principals. The **kadmin** command offers any administrator listed in the **admin_acl.get** file access from any network-connected system running PSSP Kerberos V4 authentication services. The root user on the primary Kerberos V4 authentication database system can also directly examine the database content by viewing the database backup file in **/var/kerberos/database/slavesave**.

Using **kadmin**, for example:

```
kadmin
Welcome to the Kerberos Administration Program, version 2
Type "help" if you need it.
admin: get ben
Admin password:
Info in Database for ben.:
   Max Life: 255   Exp Date: Fri Dec 31 23:59:00 1999

   Attribs:  00  key: 0 0
admin: quit
Cleaning up and exiting
```

Using the database backup file:

```
grep "^rcmd node3sw" /var/kerberos/database/slavesave
rcmd node3sw 255 1 2 0 a49bf286 d45c6560 200001010459 199503301502 root admin
```

The fields in each entry are:

- The principal's name
- The principal's instance
- The maximum ticket lifetime
- The key version of the master key used to encrypt the entry.
- The key version of the principal's secret key.
- The two halves of the encrypted private key.
- The expiration date (in Universal Coordinated Time) as YYYYMMDDHHMM
- The date the entry was created or modified
- The name and instance of the administrator who made the last update

With AFS Authentication: To display the database information for a user of AFS, an AFS administrator uses the **kas examine** command. For example:

```
kas ex -na ben -admin_user afsadm
Administrator's (afsadm) Password:

User data for ben
  key (0) cksum is 1004957312, last cpw: Mon May 22 10:12:50 1995
  password will never expire.
  An unlimited number of unsuccessful authentications is permitted.
  entry never expires.  Max ticket lifetime 25.00 hours.
  last mod on Mon May 22 10:12:50 1995 by afsadm
```

Changing User Passwords for DCE

If you are using integrated login, see "Changing Passwords" in the "AIX/DCE Security Integration" chapter of the book *IBM DCE 3.1 for AIX: Administration Guide–Core Components*. Otherwise, see "Modifying Accounts" in that book.

Changing User Passwords For Kerberos V4

To change a password for a principal in the Kerberos V4 authentication database, a PSSP Kerberos V4 authentication database administrator can use either the **kpasswd** command or the **kadmin** program's **change_password** subcommand. You can issue these commands from any system running PSSP Kerberos V4 authentication services and do not require a prior **k4init**.

To use the **kpasswd** command:

1. Enter the **kpasswd** command with the name of the principal whose password is being changed:

   ```
   kpasswd -n name
   ```

2. At the prompt, enter the old password
3. At the prompt, enter the new password
4. At the prompt, reenter the new password

To use the **kadmin** program:

1. Enter the **kadmin** command:

   ```
   kadmin
   ```

   A welcome message and explanation of how to ask for help are displayed.

2. Enter the **change_password** or **cpw** subcommand with the name of the principal whose password is being changed:

   ```
   cpw name
   ```

   The only required argument for the subcommand is the principal's name.

3. At the prompt, enter your **admin** password
4. At the prompt, enter the principal's new password
5. At the prompt, reenter the principal's new password

To change your own **admin** instance password, you can use either the **kpasswd** command or the **kadmin** program's **change_admin_password** subcommand.

To use the **kpasswd** command:

1. Enter the **kpasswd** command with your **admin** instance name:

   ```
   kpasswd -n name -i admin
   ```

   where *name* is usually replaced with **root**.

2. At the prompt, enter your old **admin** password
3. At the prompt, enter your new **admin** password
4. At the prompt, reenter your new **admin** password

To use the **kadmin** program:

1. Enter the **kadmin** command:

   ```
   kadmin
   ```

   A welcome message and explanation of how to ask for help are displayed.

2. Enter the **change_admin_password** or **cap** subcommand:

   ```
   cap
   ```

3. At the prompt, enter your old **admin** password
4. At the prompt, enter your new **admin** password
5. At the prompt, reenter your new **admin** password

Changing User Ticket Expiration for DCE

In addition to changing the password, you might want to change either the expiration date of the principal or its maximum ticket lifetime, though these are not as likely to be necessary. If DCE is to be used with parallel jobs run under LoadLeveler and Parallel Environment, the ticket lifetime needs to be long enough to allow for the expected longest running job to complete.

See "Setting Ticket Lifetimes" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Changing User Ticket Expiration For Kerberos V4

In addition to changing the password, you might want to change either the expiration date of the principal or its maximum ticket lifetime, though these are not as likely to be necessary.

With PSSP Kerberos V4 authentication

To change the ticket expiration, the root user on the primary Kerberos V4 authentication database system must use the **kdb_edit** command, just as when adding new principals locally. Instead of not finding the specified principal, the command finds it already exists, and prompts for changes to all its attributes, starting with the password, followed by the expiration date and maximum ticket lifetime.

The following example shows the use of the **kdb_edit** command to change a user principal's maximum ticket lifetime from the default value (30 days) to approximately 7 days:

```
#/usr/kerberos/etc/kdb_edit -n
Opening database...
Previous or default values are in [brackets] ,
enter return to leave the same, or new value.

Principal name: johndoe
Instance:

Principal: johndoe, Instance: , kdc_key_ver: 1
Change password [n] ?
Expiration date (enter yyyy-mm-dd) [ 1996-09-01 ] ?
Max ticket lifetime [ 255 ] ? 171
Attributes [ 0 ] ?
Edit O.K.
Principal name:
#
```

Use the **chkp** command to change the maximum ticket lifetime and expiration date for Kerberos V4 principals in the Kerberos V4 authentication database.

When logged into a system that is a Kerberos V4 authentication server, the root user can run the **chkp** command directly. Additionally, any users who are Kerberos V4 database administrators listed in the **/var/kerberos/database/admin_acl.mod** file can invoke this command remotely through a Sysctl procedure of the same name. The administrator need not be logged in on the server host to run **chkp** through Sysctl, but must have a Kerberos V4 ticket for that **admin** principal (*name*.**admin**).

In the following example, **chkp** is used by root to set the expiration date to the end of the year 2000 and the lifetime to approximately two weeks for several existing principals:

```
#chkp -e 2000-12-31 -l 181 joeuser joe.admin harry.admin user12

#
```

In the following example, the maximum ticket lifetime for new users (those added subsequently) is set to approximately a week. **control2** is the Kerberos V4 server host name. The user has previously obtained a ticket as *name*.**admin**, for whom an entry exists in the **admin_acl.mod** file:

```
$sysctl -h control2

Sysctl (Version 1.1) on control2.abc.com
sysctl> chkp -l 170 default
sysctl> lskp default
default tkt-life: 7d+08:50 key-vers: 1 expires: 2037-12-31 23:59
sysctl> quit

$
```

For more information, see **chkp** in the book *PSSP: Command and Technical Reference*.

With AFS Authentication

To change the attributes of AFS user principals, use the **kas setfields** command. For example, to change the maximum ticket lifetime to two days:

```
kas setfields -name ben -lifetime 48:00 -admin_user afsadm
administrator's (afsadm) Password:
```

Removing Users for DCE

See "Deleting a User" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Removing Users For Kerberos V4

With PSSP Kerberos V4 authentication

Use the **rmkp** command to remove Kerberos V4 principals from the Kerberos V4 authentication database.

When logged into a system that is a Kerberos V4 authentication server, the root user can run the **rmkp** command directly. Additionally, any users who are Kerberos V4 database administrators listed in the **/var/kerberos/database/admin_acl.add** file can invoke this command remotely through a Sysctl procedure of the same name. The administrator need not be logged in on the server host to run **rmkp** through Sysctl, but must have a Kerberos V4 ticket for that **admin** principal (*name*.**admin**).

Normally, this command requires you to confirm your intention to remove each principal as it is processed. An option is provided (**-n**) to allow the command to suppress prompting and run non-interactively. Running **rmkp** through Sysctl requires non-interactive execution; and doing so forces that option to be applied. When running **rmkp** interactively, the root user can select multiple principals by name or instance using the operand notation *name.* or *.instance* as for the **lskp** command.

Removed entries are preserved in an ASCII text file, in the format produced by the **kdb_util dump** command. If a principal must be recovered after having been removed, the line in that file containing its entry can be appended to a current database backup file (see “Backing Up and Restoring Kerberos V4 Authentication Information” on page 64) to be restored using **kdb_util load**. The following example shows how **rmkp** could be used by root to remove obsolete entries after the host name on the control workstation has been changed from **cwksta** to **cwksta2**:

```
#rmkp -v .cwksta

Confirm removal of principal hardmon.cwksta? (y or n): y
hardmon.cwksta was removed
Confirm removal of principal rcmd.cwksta? (y or n): y
rcmd.cwksta was removed
Removed entries were saved in /var/kerberos/database/rmkp.save.3036

#
```

In the following example **rmkp** is used to remove two principals. **control2** is the Kerberos V4 server host name. The user has previously obtained a ticket as *name*.**admin**, for whom an entry exists in the **admin_acl.add** file:

```
$sysctl -h control2 rmkp -v pauline frank

pauline was removed
frank was removed
Removed entries were saved in /var/kerberos/database/rmkp.save.18365

$
```

With AFS Authentication

An AFS administrator can delete principals directly by using the **kas delete** command. For example:

```
kas delete -name ben -admin_user afsadm
Administrator's (afsadm) Password:
```

Managing Authorization Information

This section includes the following topics for managing authorization information:

- Managing access by group membership.
- Managing access using ACL files.

Managing Access by Group Membership

This section includes the following topics for authorizing access by group membership:

- Authorizations assigned to groups.
- Adding, deleting, and displaying group members.

Authorizations Assigned to Groups for DCE

Table 2 lists the default DCE group names and the SP trusted services that use them.

Table 2 (Page 1 of 2). DCE Group Names for use of SP Trusted Services

DCE Default Group Name	Purpose of Group
haem-users	Authorizes use of Event Management.*
hm-admin	Authorizes administrative tasks used to manage the SP Hardware Monitor.
hm-control	Authorizes all SP Hardware Monitor tasks except administration and includes hm-monitor authorization.
hm-monitor	Authorizes monitoring of SP hardware. This is read-only access to the SP Hardware Monitor.
sdr-admin	Authorizes SDR tasks on partitioned classes.*
sdr-write	Authorizes all SDR updates to existing partitioned classes, but not the addition or deletion of classes or other administrative tasks.*
sdr-system-class-admin	Authorizes all SDR tasks on global system classes
sdr-system-class-write	Authorizes SDR updates to existing system classes, but not the addition or deletion of system classes or other administrative tasks.

Table 2 (Page 2 of 2). DCE Group Names for use of SP Trusted Services

DCE Default Group Name	Purpose of Group
switchtbld-clean	Authorizes cleanup, the unloading, of switch tables.
switchtbld-load	Authorizes loading of switch tables.
switchtbld-status	Authorizes querying the status of loaded switch tables.
sysctl-cwsroot	Authorizes use of certain switch management commands by non-root users of SP Perspectives. Sysctl creates a group entry for it in the **etc/sysctl.rootcmds.acl** DCE ACL file.
sysctl-default	Sysctl creates a group entry for it in any ACL added by customization (not supported by IBM).
sysctl-logmgt	Authorizes use of log management commands by non-root users. Sysctl creates a group entry for it in the **etc/logmgt.acl** DCE ACL file.
sysctl-master	Authorizes full access to all Sysctl facilities including Sysctl administration. Sysctl creates a group entry for it in the **etc/sysctl.acl** DCE ACL file.
sysctl-mmcmd	Authorizes access to GPFS commands. Sysctl creates a group entry for it in the **etc/sysctl.mmcmd.acl** DCE ACL file.
sysctl-pman	Authorizes access to Problem Management commands. Sysctl creates a group entry for it in the **etc/sysctl.pman.acl** DCE ACL file.
sysctl-vsd	Authorizes access to Virtual Shared Disk commands. Sysctl creates a group entry for it in the **etc/sysctl.vsd.acl** DCE ACL file.

***** To allow separate groups of users to access the resources of each system partition, this group can by partitioned during installation and configuration by using the **spsec_overrides** file.

Authorizations Assigned to Groups For AIX

AIX group names related to PSSP are **shutdown**, **cshut**, and **hagsuser**. Use the **shutdown** or **cshut** groups to authorize users to run the **cstartup** and **cshutdown** commands. Use the **hagsuser** group to authorize non-root users to use Group Services.

Adding, Deleting, and Displaying Group Members for DCE

See "Maintaining Membership Lists" and "Project Lists" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Adding, Deleting, and Displaying Group Members For AIX

See "Users and Groups" in the book *AIX Version 4.3 System Management Concepts: Operating Systems and Devices* and *AIX Version 4.3 System Management Guide: Operating Systems and Devices*.

Managing Access using ACL Files

This section includes the following topics:

- AIX Remote Command Authorization Files
- Managing DCE ACLs for SP Trusted Services
- Managing Kerberos V4 ACLs for SP Trusted Services

AIX Remote Command Authorization Files

The methods of authorizing users for access on a target system vary according to the authentication methods used. There is one type of authorization file for each authentication method in the SP system. The control workstation and the nodes which are configured for an authorization method maintain their own copy of that method's authorization file. For all methods, access is based on the contents of a file in the target user's home directory:

- DCE – the .k5login file contains a list of authorized Kerberos V5 principal names.
- Kerberos V4 – the .klogin file contains a list of authorized Kerberos V4 principal names. Any nodes running a release earlier than PSSP 3.2 require Kerberos V4.
- Standard AIX – the .rhosts file contains a list of authorized source host names and user names.

See “AIX Remote Command Authorization Files” on page 98 for more information.

Managing DCE ACLs for SP Trusted Services

Generally, to manage DCE ACL entries you can use the DCE **dcecp acl** command and related SMIT panels. PSSP 3.2 provides the **spacl** command and the **spauth_spacl** SMIT fastpath to simplify managing ACLs specifically for the Hardware Monitor and Sysctl SP trusted services.

The SP ACL management component of PSSP offers the following advantages:

1. ACL files for multiple instances of the Sysctl service can be managed consistently and efficiently across the entire SP system in one transaction.
2. When using SMIT, you can select the service and the objects for which the action is to be performed, which means you avoid a lot of manual data entry.

You can perform the following actions:

List SP ACL entries.
Add SP ACL entries.
Change SP ACL entries.
Remove SP ACL entries.
Show permissions defined for a service.
Check your permissions on an object.

These actions operate by default on all instances of an object's ACL in the default SP system partition. When you do not want to act on all instances you can define a subset of instances in any of the following ways:

- Selecting an SP system partition.
- Selecting a predefined node group.

- Entering a comma-delimited list of node numbers or the name of a file that contains such a list.
- Setting a node range with starting frame number, starting slot number, and node count.

Understanding the Information Used by SP ACL Management: You ought to be familiar with the naming convention for DCE entities such as service principals, access groups, and CDS paths, which are used by SP security services in PSSP. (See "DCE Entities used by SP Security Services" on page 23.)

Note: If you used the **spsec_overrides** file to change the name for the **ssp/sysctl** or the **ssp/hardmon** service or to change the name of access groups, remember to use the changed names as input to the **spacl** command. When you use SMIT, the selection lists contain the changed names.

Object names are given by the SP trusted service by which they are created and controlled. The **spauth_spacl** SMIT interface shows a list of the objects on which you can operate. You can also use the **spacl** command to list them.

Some actions ask you to supply an ACL entry in the DCE standard form:

type:*key*:*permissions*

For information on how to specify *type* and *key*, see the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*. For information on *permissions* for the Hardware Monitor, see "Authority" on page 312. For information on Sysctl *permissions*, see "DCE ACLs" on page 119.

Types of DCE ACL Entries: Sysctl creates only group entries in its DCE ACLs. However, the following entry types are supported:

mask_obj
unauthenticated
user
group
other_obj
any_other
foreign_user
foreign_group
foreign_other

The following entry types are allowed by Sysctl and DCE, but are meaningless, because Sysctl does not use delegated credentials:

user_delegate
group_delegate
other_obj_delegate
any_other_delegate
foreign_user_delegate
foreign_group_delegate

The following entry types are not allowed in Sysctl ACLs by DCE:

user_obj
group_obj
user_obj_delegate

group_obj_delegate

Querying Access Permissions Defined by a Service: SP trusted service objects are protected by different sets of access permissions as defined by the service that owns them. You can list the permissions defined for objects relative to the service. You can use the SMIT fastpath **spacl_perms** to get directly to that part of the **spauth_spacl** interface, or you can use the **spacl** command.

For information on the permissions used by the hardware monitor, see "Authority" on page 312. For information on Sysctl permissions, see "Permissions in Sysctl ACLs" on page 119.

For example, to see the permissions defined for Hardware Monitor objects, run the following command:

```
spacl -a permissions -s ssp/hardmon
```

The output is a list of single lower case letters and their meanings.

Checking Your Access Permissions to Objects: Before you change SP ACL entries, you might want to check if you have permission to make the changes. For example, to see if you can change the ACL of the Hardware Monitor object frame1/slot1, run the command:

```
spacl -a check -s ssp/hardmon -o frame1/slot1
```

The output is a list of the access permissions you have for that object.

Understanding the Access Permissions Needed to Perform SP ACL Management Actions: Although the set of access permissions are defined by each service, all sets must contain the following:

- **c** – permission to change the ACL of the object.
- **t** – permission to query your own access permissions to the object.

In order to successfully run any of these SMIT interfaces or commands, there must be an ACL entry associated with the object (frame1/slot1 in the previous examples) that contains your principal name or a group in which you are a member where your effective permissions include **t**.

Examples of Listing ACL Entries: To list ACL entries using SMIT:

TYPE	smit spacl_list
SELECT	the SP trusted service such as `ssp/hardmon`
SELECT	the name of the object such as `system`
PRESS	`OK`

To list ACL entries using the CMI, run a command similar to the following which lists the entries for the **system** object:

```
spacl -a show -s ssp/hardmon -o system
```

Examples of Adding ACL Entries: To add ACL entries using SMIT:

TYPE	smit spacl_add
SELECT	the SP trusted service such as `ssp/hardmon`

SELECT	the name of the object such as `hardmon`
TYPE	the ACL entry such as `user:joe`
TYPE	the permissions such as `at`
PRESS	`OK`

To add ACL entries using the CMI, run a command similar to the following which adds an entry for user **joe** to the **hardmon** object:

```
spacl -a add -s ssp/hardmon -o hardmon -e user:joe -p at
```

Examples of Changing ACL Entries: To change ACL entries using SMIT:

TYPE	smit spacl_change
SELECT	the SP trusted service such as `ssp/hardmon`
SELECT	the name of the object such as `hardmon`
TYPE	the ACL entry such as `group:hm-admin`
TYPE	the permissions such as `at`
PRESS	`OK`

To change ACL entries using the CMI, run a command similar to the following which changes the permissions in the **hm-admin** group entry for the **hardmon** object in the Hardware Monitor:

```
spacl -a change -s ssp/hardmon -o hardmon -e group:hm-admin -p at
```

Examples of Removing ACL Entries: To remove ACL entries using SMIT:

TYPE	smit spacl_remove
SELECT	the SP trusted service such as `ssp/hardmon`
SELECT	the name of the object such as `hardmon`
TYPE	the ACL entry such as `user:joe`
PRESS	`OK`

To change ACL entries using the CMI, run a command similar to the following which removes an entry for the user **joe** from the **hardmon** object in the Hardware Monitor:

```
spacl -a remove -s ssp/hardmon -o hardmon -e user:joe
```

Examples of Showing All ACL Permissions: To show all ACL permissions using SMIT:

TYPE	smit spacl_perms
SELECT	the SP trusted service such as `ssp/hardmon`
SELECT	the name of the object such as `system`
PRESS	`OK`

To show all ACL permissions using the CMI, run a command similar to the following which shows all the permissions for the **system** object in the Hardware Monitor:

```
spacl -a perm -s ssp/hardmon -o system
```

Examples of Checking Your ACL Permissions: To check your ACL permissions using SMIT:

TYPE	smit spacl_check
SELECT	the SP trusted service such as `ssp/hardmon`
SELECT	the name of the object such as `frame1/slot1`
PRESS	`OK`

To check your ACL permissions using the CMI, run a command similar to the following which shows your permissions for the **frame1/slot1** object in the Hardware Monitor:

```
spacl -a check -s ssp/hardmon -o frame1/slot1
```

Managing Kerberos V4 ACLs for SP Trusted Services

There is no single facility that provides an ACL management interface for Hardware Monitor and Sysctl ACL files.

A single ACL file named **hmacls** is used for authorization of Kerberos V4 principals by the Hardware Monitor. Its entries contain the object name in addition to the principal name and permissions. You can change this ASCII file using the text editor of your choice. For more information about managing Hardware Monitor ACL files, see “Step 1: Authorize Users for the SP System Monitor” on page 313.

Sysctl ACLs are also ASCII files that can be edited directly. The path name for them, relative to the root directory (/), is the same as the DCE object name used to reference the DCE Sysctl ACLs. Sysctl provides built-in ACL management procedures that you can use to create, change, list, and remove these files. Because Sysctl provides parallel access to multiple Sysctl servers, you can update multiple instances on a single request, as with the SP ACL management facility for DCE ACLs. For more information on Sysctl ACL management, see “Sysctl Files” on page 117. For information on the format of Sysctl ACL files, see "sysctl_acl File" in the book *PSSP: Command and Technical Reference*.

Managing the Security Configuration

Managing the security configuration involves the following topics:

- Displaying the current security configuration
- Changing the security configuration
- Maintaining the authentication databases

Displaying the Current Security Configuration

Displaying the current security configuration involves the following topics:

- Showing information for all system partitions
- Checking the AIX remote command authentication method setting
- Checking the SP trusted service authentication method setting

Showing Information for all System Partitions

When you display the SP configuration database information for the SP system partitions, the output shows four attributes that define the security configuration for each partition:

auth_install lists the optional facilities for authentication that are, or will be, installed on the nodes in the partition.

auth_root_rcmd lists the AIX remote command authorization methods that are, or will be, used by the root user on nodes in the partition.

auth_methods lists the AIX remote commands authentication methods that are, or will be, enabled on nodes in the partition.

ts_auth_methods lists the trusted services authentication methods that are, or will be, enabled on nodes in the partition.

For information on how to set the security configuration for a partition, see "Changing the Security Configuration" on page 58.

To show information for all system partitions using SMIT:

TYPE smit list_syspar

To show information for all system partitions using the CMI, run the following command:

```
splstdata -p
```

The output is similar to the following:

```
List System Partition Information

System Partitions:
--------------------------------------------------------------------
system3p0
system3p1
system3p2

Syspar: system3p0
--------------------------------------------------------------------
syspar_name system3p0
ip_address 19.4.60.145
install_image default
syspar_dir /spdata/sys1/syspar_configs/3nsb0isb/config.4_4_40/
layout.3syspar-coex/syspar.3.system3p0
code_version PSSP-2.4
haem_cdb_version 939568157,265012085,0
auth_install dce:k4
auth_root_rcmd dce:k4
ts_auth_methods dce:compat
auth_methods k5:k4:std
```

```
Syspar: system3p1
-------------------------------------------------------------------
syspar_name system3p1
ip_address 19.4.60.162
install_image default
syspar_dir /spdata/sys1/syspar_configs/3nsb0isb/config.4_4_40/
layout.3syspar-coex/syspar.1.system3p1
code_version PSSP-2.4
haem_cdb_version 939568026,670463251,0
auth_install k4
auth_root_rcmd k4
ts_auth_methods compat
auth_methods k4:std

Syspar: system3p2
------------------------------------------------------------------
syspar_name system3p2
ip_address 19.4.60.183
install_image bos.obj.ssp.433
syspar_dir /spdata/sys1/syspar_configs/3nsb0isb/config.4_4_40/
layout.3syspar-coex/syspar.2.system3p2
code_version PSSP-3.2
haem_cdb_version 939568100,243454795,0
auth_install dce
auth_root_rcmd dce:std
ts_auth_methods dce
auth_methods k5:std
```

Checking the AIX Remote Command Authentication Method Setting

As root on the control workstation, use the **lsauthpar -v** command to display the setting in the SP configuration database and also verify that the setting on each node in the partition matches it.

For example:

```
lsauthpar -vp system3p1
```

The output is similar to the following:

```
Remote command authentication methods for the partition: k4:std

kerberos: Couldn't get credentials for the server: Server not
found in Kerberos database.

kerberos: Couldn't get credentials for the server: Server not
found in Kerberos database.

spk4rsh: 0041-004 Kerberos rcmd failed. rcmd protocol failure.

system3n25.xyz.com: A remote host did not respond within the
timeout period.

No discrepancies were found.
```

The example shows some common error messages you might receive. The first two are the result of the **rsh** command attempting and failing to get Kerberos V5 credentials, because Kerberos V5 is the enabled authentication method on the control workstation. Since Kerberos V5 is not being used in this partition, however, no DCE service principal exists for the targeted nodes. The last two error messages indicate that the **rsh** command was unable to connect to one node in the partition to check its local setting. The last output line indicates that none of the contacted nodes in the partition has a setting that differs from the one displayed on the first line.

Checking the SP Trusted Service Authentication Method Setting

As the root user on the control workstation, use the **lsauthpts -v** command to display the setting in the SP configuration database and also verify that the setting on each node in the partition matches it.

For example:

```
SP_NAME=system3p1 lsauthpts -v
```

The output is similar to the following:

```
Trusted services authentication methods for the partition: dce:compat

No discrepancies were found.
```

Changing the Security Configuration

Changing the security configuration can involve the following:

- Enabling and disabling AIX remote command authentication methods
- Enabling and disabling SP trusted services authentication methods
- Adding DCE authentication
- Removing DCE authentication
- Adding Kerberos V4 authentication
- Removing Kerberos V4 authentication

Enabling and Disabling AIX Remote Command Authentication Methods

The set of authentication methods to be used by the AIX remote commands can be specified using AIX commands. The PSSP security services provide additional commands to simplify your work.

The AIX base operating system provides the **chauthent** command to set which authentication methods are to be activated for use by the AIX remote commands on an AIX host. All methods specified as arguments in the command are enabled and all others are disabled. If you were to use the **chauthent** command, you would have to run it with the same set of authentication methods on every host within an SP system partition. Another SP system partition can have a different set, but that set must be on every node in the system partition.

The SP security services component of PSSP provides the **chauthpar** command. Setting or changing the remote command authentication methods on the SP system involves the following:

1. The **lsauthpar** command to check the AIX remote command authentication setting in each SP system partition.

2. The **lsauthent** command to check the local AIX remote command authentication setting in the control workstation or a local host.
3. The **chauthpar** command run in each SP system partition. The setting maintained by this command applies to all nodes in the partition.
4. The **chauthent** command run on the control workstation. The control workstation must have the set that is the union of the methods used in all of the SP system partitions plus any methods used only on the control workstation.

Keep in mind, for remote commands to work in each SP system partition, the following restrictions apply:

- The Kerberos V4 method is required if any node in the SP system partition is running an earlier level than PSSP 3.2.
- At least one authentication method must be enabled.
- The respective root user authorization files must be configured in the system partition for each authentication method that is enabled.
- The Kerberos V4 authentication method cannot be enabled if it has not first been installed and configured on the nodes in the SP system partition.
- If the authentication methods enabled for use by SP trusted services includes DCE, the authentication methods enabled for use by the AIX remote commands must include Kerberos V5.
- If the authentication methods enabled for use by SP trusted services includes compatibility, the authentication methods enabled for use by the AIX remote commands must include Kerberos V4.

To enable and disable authentication methods for remote commands using SMIT:

TYPE	smit spauth_methods
SELECT	the SP system partition such as `system3p2`
SELECT	one or more authentication methods such as `k5`, `k4`, `std` (Those you select become enabled, the rest become disabled.)
PRESS	`OK`

To enable and disable authentication methods using the CMI, run a command similar to the following which enables AIX remote command authentication using Kerberos V5 and standard AIX methods for the partition named **system3p2**:

```
chauthpar -vp system3p2 k5 std
```

The output is similar to the following:

```
The remote command authentication methods for this host are currently k5:k4:std

The authentication methods by partition are currently
system3p0 k5:k4:std
system3p1 k4:std
system3p2 std

The partition to be modified is system3p2

spk4rsh: 0041-004 Kerberos rcmd failed. rcmd protocol failure.

system3n21.xyz.com: A remote host did not respond within the timeout period.
```

The example shown includes some common error messages you might receive. They indicate that the **rsh** command was unable to connect to one node in the partition to change its local setting. It is changed automatically the next time the node is booted.

Enabling and Disabling SP Trusted Services Authentication Methods

The SP security services component of PSSP provides the **chauthpts, lsauthpts**, **chauthts**, and **lsauthts** commands. Setting or changing the authentication methods to be used by SP trusted services involves the following:

1. The **lsauthpts** command to query which authentication methods are active in the system partition.
2. The **lsauthts** command to query which authentication methods are active in the control workstation or a local host.
3. The **chauthpts** command run for each SP system partition. The setting maintained by this command applies to all nodes in the partition.
4. The **chauthts** command run on the control workstation. The control workstation must have the set that is the union of the methods used in all of the SP system partitions plus any methods used only on the control workstation.

Keep in mind, for SP trusted services to work in each SP system partition, the following restrictions apply:

- The compatibility method is required if any node in the SP system partition is running an earlier level than PSSP 3.2.
- No method can be enabled which has not first been installed and configured on the nodes in the SP system partition.
- If the authentication methods enabled for use by SP trusted services includes DCE, the authentication methods enabled for use by the AIX remote commands must include Kerberos V5.
- If the authentication methods enabled for use by SP trusted services includes compatibility, the authentication methods enabled for use by the AIX remote commands must include Kerberos V4.

To enable and disable authentication methods for SP trusted services using SMIT:

TYPE	smit spauth_tsmethods
SELECT	the SP system partition such as `system3p2`

SELECT one or more authentication methods such as `dce`, `compat` (Those you select become enabled, the rest become disabled.)

PRESS `OK`

To enable and disable authentication methods using the CMI, run a command similar to the following which enables SP trusted services authentication using only the DCE method for the partition named **sp1partA**:

```
export SP_NAME=sp1partA
chauthpts -v dce
```

The output is similar to the following:

```
The trusted services authentication methods for this host are currently dce:compat
The authentication methods by partition are currently
sp1partA dce:compat
sp1partB compat
The partition to be modified is sp1partA
```

As a result, the compatibility method is disabled and only the DCE method remains enabled as the authentication method for SP trusted services in partition sp1partA.

Both the **chauthpar** and **chauthpts** commands use the -c flag. This flag specifies that the command operate only on the control workstation, changing the SDR and AIX settings as specified by the command without making any changes on the nodes in the partition. Use the -c flag when you are enabling a method that is newly configured on the control workstation, but not yet enabled on the nodes. Use the **chauthpar** and **chauthpts** commands without the -c flag if you are removing a previously established authentication method from the nodes.

Adding DCE Authentication to the SP System

See the book *PSSP: Installation and Migration Guide*.

Removing DCE Authentication from the SP System

If your authentication requirements change, you might want to remove, from one or more SP system partitions or from the entire SP system, the capability of SP trusted services to use DCE authentication. You must have DCE cell administrator authority to run the **rm_spsec** command. These instructions show how to perform this task from the control workstation. If you want to do it from some other suitably configured workstation, see the **rm_spsec** command in the book *PSSP: Command and Technical Reference*.

To remove DCE authentication capability, do the following:

1. Any partition that has only the **k5** authentication method enabled for AIX remote commands must have another method enabled in its place. Follow the procedures for enabling the other method before attempting to disable the **k5** authentication method.
2. Establish authorizations for the Hardware Monitor and Sysctl SP trusted services, using either **compat** or no authentication methods.
3. Disable the **dce** authentication method in all SP system partitions where it is enabled. See “Enabling and Disabling SP Trusted Services Authentication Methods” on page 60.

4. Disable the **k5** authentication method in all SP system partitions where it is enabled. See “Enabling and Disabling AIX Remote Command Authentication Methods” on page 58.

5. Remove **k5** from the AIX remote command authorization methods for each partition in which it is included. See “Displaying the Current Security Configuration” on page 55 for how to determine the current setting. Use the **spsetauth -d** command. See the book *PSSP: Command and Technical Reference*.

6. Remove **dce** from the selected security capabilities for each partition in which it is included. See “Displaying the Current Security Configuration” on page 55 for how to determine the current setting. Use the **spsetauth -i** command. See the book *PSSP: Command and Technical Reference*.

7. Run the **rm_spsec** command to remove key files and DCE ACL database files on all affected nodes. For example, while logged in as root on the control workstation, issue the following command:

   ```
   SP_NAME=syspar dsh -av /usr/lpp/ssp/bin/rm_spsec -t local
   ```

8. Run the **rm_spsec** command to remove key files for partition-sensitive services on the control workstation. For example, while logged in as root on the control workstation, issue the following command for each affected partition:

   ```
   rm_spsec -t local -p syspar
   ```

9. If DCE authentication capability is to be removed from all the SP system partitions, run the **rm_spsec** command to remove other key files and DCE ACL database files on the control workstation. For example, while logged in as root on the control workstation, issue the following command:

   ```
   rm_spsec -t local
   ```

10. Principles, groups and **rpc** entries for the nodes, partitions, and control workstation must be removed from the DCE database. With DCE cell administrator authority, do the following:

    a. Run the following command on the control workstation for each affected SP system partition:

       ```
       rm_spsec -t admin -p syspar
       ```

    b. Run the following command on the control workstation for each node removed from the DCE cell:

       ```
       rm_spsec -t admin node_dce_hostname
       ```

    c. Run the following command for the control workstation:

       ```
       rm_spsec -t admin cws_dce_hostname
       ```

11. Examine your DCE database to verify that all SP-created principles and groups for the control workstation, partitions, and nodes have been removed. The database should still contain host and ftp principles for the control workstation and nodes.

12. Remove the ftp and host principles for all adapters on the nodes and the control workstation. On the control workstation remove the node information by doing the DCE SMIT function "admin only unconfiguration for another machine". Do this for each configured adapter. For example, on the "admin only unconfiguration for another machine" panel in the "Machine's name or TCP/IP address" field, enter the host name for the additional adapters. Remove the

control workstation ftp and host principles, if necessary, using "local only unconfiguration for this machine".

13. So far you have disabled and removed the specific resources needed to use DCE security services for the **k5** and **compat** authentication methods. You have not made DCE unavailable on the nodes or control workstation. If you do want to make DCE unavailable and completely remove all DCE capabilities from the SP system, follow the DCE guidelines for stopping DCE daemons and unconfiguring DCE client and server systems.

Adding Kerberos V4 Authentication to an SP System Operating without It

See the book *PSSP: Installation and Migration Guide*.

Removing Kerberos V4 Authentication

Note: Do not do this if any SP system partition is running a version earlier than PSSP 3.2.

To take away your SP system's capability to run Kerberos V4 authentication, do the following:

1. Any partition that has only the **k4** authentication method enabled for AIX remote commands must have another method enabled in its place. Follow the procedures for enabling the other method before attempting to disable the **k4** authentication method.
2. Establish authorizations for the Hardware Monitor and Sysctl SP trusted services, using either DCE authentication or no authentication methods.
3. Disable the **k4** authentication method in all SP system partitions where it is enabled. See “Enabling and Disabling AIX Remote Command Authentication Methods” on page 58.
4. Disable the **compat** authentication method in all SP system partitions where it is enabled. See “Enabling and Disabling SP Trusted Services Authentication Methods” on page 60

Maintaining the Authentication Databases

Maintaining your authentication database involves the following topics:

- Backing up and restoring authentication information.
- Stopping and restarting authentication servers.
- Managing server keys.
- Changing the master key for the administration database.

Backing Up and Restoring DCE Authentication Information

See "Backing Up and Restoring the Registry Database" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Backing Up and Restoring Kerberos V4 Authentication Information

Keeping a current backup of the database contents is an important administrative task. The database utility commands that are available to the root user on the primary authentication database system include functions to use for this task. If you have secondary authentication servers and the documented installation steps for were followed, a backup of the database is automatically created every time the **cron** file entry propagates the database to the secondary servers.

The **push-kprop** script, invoked daily or at some other interval from the root user's **cron** file, creates a backup file in ASCII format called **slavesave**. This file is created in the database directory, where it is accessible only to the root user. If you want to create a backup file without using **push-kprop** (for example, if you do not have secondary servers and want to avoid the mail messages **push-kprop** sends to root), just add a **cron** entry to invoke the following command instead:

```
kdb_util dump /var/kerberos/database/slavesave
```

The result is a backup file with the same path name that can be used with the **kdb_util load** command to recover from a lost or corrupted database. You can also view or print it to examine the database contents.

Stopping and Restarting DCE Authentication Servers

See "Starting and Stopping DCE 3.1 for AIX" in the book *IBM DCE Version 3.1 for AIX: Quick Beginnings*.

Stopping and Restarting Kerberos V4 Authentication Servers

If a Kerberos V4 daemon fails, it records an error condition in its log file and stops responding to client requests. Under these circumstances, you would need to restart it, after correcting the problem which caused the failure. There can be other circumstances, such as application of certain maintenance, where you might also have to stop and then restart one or more of the daemons that provide Kerberos V4 services. Each host that is an authentication server has two Kerberos V4 daemons that are started when the system is booted. The primary authentication server runs the **kerberos** daemon to provide ticket-granting services and the **kadmind** daemon to provide authentication database administration. Each secondary authentication server host also runs **kerberos**, and also the **kpropd** daemon, which is the "catcher" for database updates propagated from the primary server, usually via a cron job.

Authentication Daemons (Primary or Secondary Servers): To stop the Kerberos V4 authentication server, enter the command:

```
stopsrc -s kerberos
```

To restart the Kerberos V4 authentication server, enter the command:

```
startsrc -s kerberos
```

Administration Daemons (Primary Servers Only): To stop the Kerberos V4 database administration server, enter the command:

```
stopsrc -s kadmind
```

To restart the Kerberos V4 database administration server, enter the command:

```
startsrc -s kadmind
```

Database Propagation Daemons (Secondary Servers Only): To stop the Kerberos V4 database propagation server, enter the command:

```
stopsrc -s kpropd
```

To restart the Kerberos V4 database propagation server, enter the command:

```
startsrc -s kpropd
```

Managing Server Keys For DCE

In a traditional DCE environment, client and server authentication requires that the principal name and encryption key be contained in the DCE registry and in a server key file accessible by the server on the local host. Each server maintains its own key. There is one key file for each server. The server uses the information in the file to:

1. Log in to DCE as the service principal.
2. Decrypt client credentials as part of the authentication process.

A DCE cell administrator controls the expiration of service principal keys by setting the password expiration policy for the primary organization of the service principal. The default policy is that keys will never expire, but an administrator can change that default at any time.

If a password expiration policy is set for the primary organization of the service principals, then the key of each service principal must be changed before the expiration time. If not, the service will not be able to log in to DCE and authenticate clients. If DCE is the only authentication method enabled, then the service is totally disabled.

Some SP trusted services use the automatic per-node key management component while others that can also operate outside of the PSSP environment do not.

See also "Creating and Maintaining Keys and Key Files" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Using the Key Management Component: As of PSSP 3.2, the Key Management component runs in a DCE environment to manage the keys for SP trusted services. Key Management runs on the SP control workstation, SP nodes, and on other RS/6000 AIX workstations and servers that are in an SP system partition where DCE has been configured. It can be started automatically or manually, depending on the circumstances:

- On an SP node, Key Management is invoked automatically during the boot process by the **spnkeyman_start** command added to the **/etc/rc.sp** file.
- Add the following statement to the **/etc/inittab** file to cause Key Management to be started during boot processing on a stand-alone RS/6000 system:

  ```
  nkeyman:2:once:/usr/lpp/ssp/bin/spnkeyman_start
  ```
- Start the Key Management daemon manually on the control workstation after the configuration of DCE for use by the SP.
- Start or restart it manually on the control workstation after a migration.
- Restart Key Management manually on an SP host where DCE has been reconfigured.

All SP service principals that are created during SP DCE installation and configuration are placed in one SP DCE organization called **spsec-services**. The Key Management component periodically checks the password expiration information for all of the SP trusted services that use it. When a key change occurs, Key Management updates the key files on each node as needed and updates the associated registry for each service. Key management removes key files when nodes are removed, a node changes partitions, or when a service is removed from the SP system.

Ordinarily, a security administrator does not interact with the Key Management component, but for Key Management to run successfully there are several administrative restrictions:

- Enabling a password lifetime is preferred to password expiration dates.
- You can set the key lifetime for the SP DCE **spsec-services** organization with the **dcecp** command. Key Management needs sufficient time to distribute the key files when a key change is made. The key lifetime should be no less than one day. Typically, keys are valid for 30 days.
- If the key lifetime or expiration time is changed in the **spsec-services** organization, the change does not take effect until the Key Management daemon polls and recognizes the change, which happens at least once every 24 hours. To make the change effective immediately, you can stop and restart the Key Management daemon (spnkeymand) on each node where it is running using the **spnkeyman_start** command.

If services fail with authentication problems or if a password expiration policy is set for the organization of SP trusted services and something prevents the Key Management component from processing successfully, see the book *PSSP: Diagnosis Guide*.

Managing Keys Manually: You might have to change keys for services, such as Topology Services, that do not use Key Management because they use other means of authentication. The RSCT Topology Services and Reliable Message Service both use connectionless protocols (UDP/IP) for daemon to daemon communication within an SP system partition. These services use the DES encryption routines directly to provide authentication and integrity for each UDP message. This is a case where IBM suggests the administrator establish a routine to periodically do the following:

1. Change the key of the Topology Services principal using the **dcecp** command.
2. Copy the key file to all nodes in the SP system.
3. Issue a refresh of the Topology Services subsystem to make the key change effective.
4. Intermittently remove old keys but always keep the most recently expired key to ensure continuity.

See Chapter 24, “The Topology Services Subsystem” on page 347 for more information.

Other services that do not use Key Management are Event Management, Problem Management, LoadLeveler, and the RSCT Group Services.

Managing Server Keys For Kerberos V4

Management of Kerberos V4 principals centers primarily on changing passwords in accordance with local security policy. For user principals this task is straightforward and can be done using simple tools. For service principals, password maintenance requires more than periodic changes to the authentication database. It also requires creation and distribution of files containing encrypted password information to the application server hosts.

The tasks involved are:

- Creating Server Key Files
- Examining Server Key Information
- Changing Server Keys
- Distributing Kerberos V4 Server Key Files to Client Systems

Creating Server Key Files: During setup for a node or control workstation, the keys for service principals are stored in the authentication database (for use by the authentication server) and on the node corresponding to the instance in the file **/etc/krb-srvtab** (for use by the service itself). Therefore, every node in the SP system contains a file, **/etc/krb-srvtab**, that contains the keys for the services that are provided on that node. On the control workstation, the **hardmon** and **rcmd** service principals are in the file. On the nodes, the **rcmd** service principals are in the file.

The local server key files on the control workstation and on other workstations are created by the **setup_authent** command when authentication is first set up on the system.

With PSSP Authentication: The **setup_server** command creates server key files for the SP nodes. When the control workstation is a PSSP authentication server, this occurs for each node when the script is run on the node's boot server. The **setup_server** command creates the files in the **/spdata/sys1/k4srvtabs** directory. When network boot occurs during install or customization, the file is transferred to the node using **s1term** command. The node uses the file to obtain tickets and invokes authenticated **rsh** to execute a script on the boot server that deletes the file.

With AFS Authentication or No Server on the Control Workstation: When run on the control workstation for the first time, the **setup_server** command creates server key files for the SP node. The **setup_server** command creates the files in the **/spdata/sys1/k4srvtabs** directory. When network boot occurs during install or customization, the file is transferred to the node using the **s1term** command.

Examining Server Key Information: There are two programs that you can use to examine the content of a server key file on the local system, **ksrvutil** and **k4list**: To view the local system's server key file in **/etc/krb-srvtab**, enter **ksrvutil list**. The output will look like:

```
   Version    Principal
      1     rcmd.cwktr@XYZ.ABC.COM
      1     hardmon.cwktr@XYZ.ABC.COM
      1     rcmd.cwkfddi@XYZ.ABC.COM
      1     hardmon.cwkfddi@XYZ.ABC.COM
      1     rcmd.cwken0@XYZ.ABC.COM
      1     hardmon.cwken0@XYZ.ABC.COM
```

The same file, viewed by entering **k4list -srvtab** appears as:

```
Server key file:   /etc/krb-srvtab
Service         Instance        Realm      Key Version
------------------------------------------------------
rcmd            cwktr           XYZ.ABC.COM 1
hardmon         cwktr           XYZ.ABC.COM 1
rcmd            cwkfddi         XYZ.ABC.COM 1
hardmon         cwkfddi         XYZ.ABC.COM 1
rcmd            cwken0          XYZ.ABC.COM 1
hardmon         cwken0          XYZ.ABC.COM 1
```

To examine the server key file in the **/spdata/sys1/k4srvtabs** directory for a node whose host name is `sp2node8`, you would enter `ksrvutil list -f /spdata/sys1/k4srvtabs/sp2node8-new-srvtab` and the output might look like the following:

```
      1     rcmd.n08tr0@XYZ.ABC.COM
      1     rcmd.n08tr1@XYZ.ABC.COM
      1     rcmd.n08fddi@XYZ.ABC.COM
      1     rcmd.n08css0@XYZ.ABC.COM
      1     rcmd.n08en0@XYZ.ABC.COM
```

Changing Server Keys: Changing the server keys involves two responsibilities:

- Changing the server keys in accordance with local system policy
- Ensuring that the server keys contained in the authentication database and in the server key files on all workstations and SP nodes always match.

You decide how frequently server keys need to be changed on your system. You may decide to set the server keys at setup time and never change them or you may decide to change them every six months. You should change the server keys if you have reason to believe system security has been compromised.

Use the **ksrvutil** command to change server keys. This command changes all of the server keys in the local server key file. The keys for all of the services provided on a single node, or the control workstation, are changed in a single call to **ksrvutil**. The keys are set to randomly generated values. The method of running **ksrvutil** to change the server keys for a node varies according to the authentication configuration of the system:

Primary Authentication Server on the Control Workstation: The **ksrvutil** command should be run on each node where the keys need to be changed. To change all of the server keys for a node to randomly generated values, enter:

```
ksrvutil change
```

The keys are updated in the node's **/etc/krb-srvtab** file and in the authentication database on the control workstation. To issue the command, you must be root. Use the **dsh** command to issue the **ksrvutil** command on multiple nodes.

You can also use the **ksrvutil** command to change server keys on the control workstation, regardless of the location of the primary authentication database.

All Other Authentication Configurations: If the primary authentication database does not reside on the control workstation, do not use the **ksrvutil** command on the nodes of the SP system. If the primary authentication database for the local realm resides in some location other than the control workstation (even if a secondary authentication database is on the control workstation) or if the system is using AFS-based authentication services, the system maintains a copy on the control workstation of the **/etc/krb-srvtab** file on each node. These files are in the directory **/spdata/sys1/k4srvtabs** with a filename of *nodename*-**new-srvtab**. Changes to these **srvtab** files should be made only to the copy on the control workstation. The **ksrvutil** command is used to change the server keys.

To change all of the server keys for a node:

1. Ensure that no users are using authenticated services on the target node
2. On the control workstation, issue:

   ```
   ksrvutil -f nodename-new-srvtab change
   ```

3. Copy the *nodename*-**new-srvtab** file from the control workstation to the **/etc/krb-srvtab** file on the target node. To do this, you can use **ftp** or, as an alternative, you can customize the node using the **spbootins** command, followed by a **netboot** on the node.

To change the server keys for a node, you must have write access to the **/etc/krb-srvtab** file on the node and read-write permission to the **/spdata/sys1/k4srvtabs/** *nodename*-**new-srvtab** file.

When you change the server keys for a node, or for the control workstation, any service tickets that have been previously issued to users for those service instances are no longer valid. An attempt to use such a ticket to authenticate the user's identity to the server will fail. A message is issued that the server could not decode the ticket authenticator. In such a case, the user must issue a **k4init** command to obtain a new ticket-granting ticket and then reissue the service request.

Refer to **ksrvutil** in the *PSSP: Command and Technical Reference* for more information. Also, refer to the *PSSP: Diagnosis Guide* for information on recreating server key files.

Distributing Kerberos V4 Server Key Files to Client Systems: Normal distribution of server key files to nodes occurs during network boot of a node. The node boot process includes the following:

- The node requests a new copy of the **srvtab** file from the control workstation.
- The Kerberos V4 key file is then copied, using the **s1term** command on the control workstation, to the **/etc/krb-srvtab** file on the node.

You can use **ftp** to transfer a new copy from the control workstation to a node at any time.

Changing the Master Key for the DCE Authentication Database

See "Changing the Registry's Master Key" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*.

Changing the Master Key for the Kerberos V4 Authentication Database

Changing the master password can enhance database security somewhat, but is no substitute for adequate physical security. Changing the master password re-encrypts the database in the new key. It does not change any passwords (keys) themselves of the Kerberos V4 principals. Therefore, it offers limited protection if the system is possibly compromised unless all passwords are changed also.

Changing the master key is one of the capabilities of the **kdb_util** command. Only the root user can issue the various **kdb_*** commands on a system configured as a PSSP authentication server. An idiosyncrasy of these commands is that they prompt only once for the new password (unlike normal password-changing protocol).

After you change the password, be sure to issue the **kstash** command to store the new key in the **/.k** file. You also have to stop and restart the Kerberos V4 daemons on the server (**kerberos** and **kadmind**). If you have secondary servers, you need to force re-propagation of the database and respawning of the backup servers also.

To change the Kerberos V4 master password, do the following on the primary server:

1. Login to Kerberos V4 as the admin principal used to set up authentication. For example:

   ```
   k4init root.admin
   ```

2. Change the password (you are prompted for old and new).

   ```
   /usr/kerberos/etc/kdb_util new_master_key /var/kerberos/database/newdb.$$
   /usr/kerberos/etc/kdb_util load /var/kerberos/database/newdb.$$
   ```

3. Replace the **/.k** file (another prompt for the new password).

   ```
   /usr/kerberos/etc/kstash
   ```

4. Stop and restart the primary authentication server daemons.

   ```
   stopsrc -s kadmind
   startsrc -s kadmind
   ```

5. If secondary servers exist, propagate the new database, copy the new master key cache to the secondary servers, and kill and respawn the secondary server daemons.

   ```
   if [[-s /var/kerberos/database/slavelist]]
   then
     /usr/kerberos/etc/push-kprop
     cat /var/kerberos/database/slavelist | while read slave
     do
       /usr/lpp/ssp/rcmd/bin/rcp /.k $slave:/
       /usr/lpp/ssp/rcmd/bin/rsh $slave \
           stopsrc -s kerberos \; startsrc -s kerberos
     done
   fi
   ```

Managing Authentication Credentials

This section discusses how to obtain, display, and delete authentication credentials and how to change authentication passwords.

When your Kerberos V4 realm is set up to use PSSP authentication servers, the PATH variable for these users should include **/usr/kerberos/bin**. When AFS authentication servers are used, the PATH variable should include **/usr/afsws/bin:/usr/kerberos/bin**.

Naming conflict if using both Kerberos V4 and DCE

Both DCE and Kerberos V4 can be installed, configured, and used on the same SP system. However, there is a naming conflict with some DCE and Kerberos V4 commands; both subsystems use **kinit**, **klist,** and **kdestroy** command names. The Kerberos V4 commands reside in **/usr/lpp/ssp/kerberos/bin**; the DCE commands reside in a DCE library.

The conflict occurs in the use of the path names in **/usr/bin**. When DCE is installed, it automatically creates symbolic links in **/usr/bin** for the DCE **kinit**, **klist,** and **kdestroy** commands.

PSSP creates the following symbolic links:

- /usr/bin/k4init points to Kerberos V4 /usr/lpp/ssp/kerberos/bin/kinit
- /usr/bin/k4list points to Kerberos V4 /usr/lpp/ssp/kerberos/bin/klist
- /usr/bin/k4destroy points to Kerberos V4 /usr/lpp/ssp/kerberos/bin/kdestroy

If you use the command names **kinit**, **klist**, or **kdestroy**, be careful when setting the command search paths to ensure that they are executing the correct commands (either the DCE or Kerberos V4 commands). As an alternative, you can use the **k4init**, **k4list**, and **k4destroy** names to invoke the specific Kerberos V4 commands.

Obtaining DCE Authentication Credentials for an Interactive AIX Session

To identify yourself to the security services when you are logged in to an interactive AIX session, use the **dce_login** or **dce_login_noexec** command. See the book *IBM DCE Version 3.1 for AIX: Administration Commands Reference*.

Obtaining Kerberos V4 Authentication Credentials for an Interactive AIX Session

This section describes how to identify yourself to the security services and obtain credentials, when you are logged in to AIX as an interactive user.

The first step in using the PSSP Kerberos V4 authentication services is to log in to the Kerberos V4 authentication system. Logging in to the SP Kerberos V4 authentication services is how you obtain a ticket-granting ticket. The ticket-granting ticket permits the client programs you invoke, such as **sysctl**, to obtain service tickets they can use to certify your identity to the servers with which they communicate.

Logging in to Kerberos V4 authentication services is a separate step from logging in to your AIX system; the Kerberos V4 principal name space is separate from the AIX user name space. The administrator can assign principal names and passwords that are the same as AIX login names and passwords.

With PSSP Kerberos V4 Authentication

Use the **k4init** command to login to the SP Kerberos V4 authentication services. You can either enter the command interactively as needed, or you could add the command to your login script (**.login** or **.profile** file). If you use Kerberos V4 authenticated services infrequently, you might prefer the first option. Another alternative for frequent users of Kerberos V4 authenticated management tools is to have the SP system or security administrator set up Kerberos V4 as an authentication method to be invoked automatically at AIX login. See “Integrating Login For Kerberos V4 with AIX” on page 42.

Use the **k4init** command to specify your Kerberos V4 principal identifier as the only argument with no options.

```
k4init principal-identifier
```

For the principal identifier, specify your Kerberos V4 user name, followed by a period and the instance, if you have more than one Kerberos V4 identity and the instance you want to use is not null. Append an ”at” sign (@) and a realm name if the realm you are logging into is not the local realm. Since the entire SP system is in a single realm, you will probably never need to specify a realm. Examples of this form of **k4init** are:

```
k4init joeuser
k4init root.admin
k4init ben@XYZ.ABC.COM
```

You might also choose to invoke the command without arguments. It responds by prompting for your Kerberos V4 name, but only for the name portion of the fully qualified identifier.

```
k4init
Kerberos name: ben
```

A common error is to omit the identifier on the command line and try to enter both name and instance in response to the prompt for the name. The result is:

```
k4init
Kerberos name: root.admin
2502-003 Bad Kerberos name format
```

Instead, you can enter the instance separately by specifying the **-i** flag on the command line and responding to the prompt:

```
Kerberos instance:
```

Similarly, the realm qualifier can only be entered as part of the command-line identifier unless you use the optional **-r** flag.

You can also use the **-l** option to request a ticket with a lifetime shorter than the maximum allowed for your principal by the database administrator. If you specify this flag, **k4init** prompts you:

```
Kerberos ticket lifetime (minutes):
```

After you enter the **k4init** command and respond to these optional prompts, the command contacts the Kerberos V4 authentication server to obtain a ticket. If no Kerberos V4 authentication server can be contacted, you are notified of a time-out and the command fails. Reasons for failure could be a missing or invalid configuration file or a networking problem.

When a ticket is obtained, **k4init** prompts you for your Kerberos V4 password. If you enter it correctly, **k4init** saves the ticket-granting-ticket in the ticket file specified by your KRBTKFILE environment variable. If this variable is undefined, your ticket is stored in the file **/tmp/tkt***uid*, where *uid* specifies your AIX user identification number.

When the ticket-granting ticket expires, subsequent attempts to be authenticated to use a Kerberos V4-supported service will fail. If the ticket-granting-ticket has expired, use **k4init** again to obtain a new ticket. There is no automatic renewal of tickets upon their expiration.

When you use **k4init**, it is valid for all processes running with your AIX user ID. It is not necessary to run this command for each window you open, as long as you have no background processes that require Kerberos V4 authentication. Note, however, that if you run authenticated applications as root in background processes or login under a shared user ID, you can potentially destroy the tickets of someone who logged in prior to you using the shared ID. In those cases you should use the KRBTKFILE environment variable to specify multiple ticket cache files. If you are uncertain of the current ticket cache file, use the **k4list** command to display the name and content of the file.

With AFS Authentication

In most situations, users of your SP system are able to use the same **k4init** command described previously without regard to which type of authentication servers are being used. The **k4init** command can always be used whenever a user is logged in to an SP node or the control workstation. When the user is logged in to another IBM RS/6000 workstation which has been set up as an authenticated services client system, **k4init** can be used if the user has the SP_NAME environment variable set to the network name of the control workstation in the local realm.

Users who do not have the SP_NAME variable set, or who wish to use more familiar AFS commands, should use the **klog.krb** command. The following example shows the format of this command:

```
klog.krb -pr root.admin -li 48:00
```

When the **admin** instance is included in the principal identifier, **klog.krb** responds with a warning message:

```
Non-null instance (admin) may cause strange behavior.
```

You can ignore this message, since these principals are not used with the AFS file system.

As with **k4init**, you can specify a lifetime but in a more reasonable *hh:mm* format.

Obtaining DCE Authentication Credentials within Scripts

This section describes how a script running noninteractively, such as from a crontab entry, can establish an identity as an authorized user of SP trusted services or AIX remote commands.

Creating a DCE Key File

See "Working with Keytabs and Key Files" in the book *IBM DCE Version 3.1 for AIX: Administration Guide–Core Components*. See also the **dce_login** command in the book *IBM DCE Version 3.1 for AIX: Administration Commands Reference*.

Logging in to DCE from a ksh Script

The following is an example of using the key file `/home/tom/dcekey` to log in as DCE principal `tom` from within a **ksh** script:

```
# Get DCE credentials, if DCE is being used for authentication
nkrb5=$(/bin/dsrvtgt tom /home/tom/dcekey)
if [[ $? ne 0 ]] then
   print "Failed to get DCE credentials"
   exit 1
fi

# dsrvtgt produces no output if DCE is not being used for authentication
if [["$nkrb5" != "" ]] then
   okrb5=$KRB5CCNAME
   export KRB5CCNAME=$nkrb5
fi
  ⋮
# Use AIX remote commands or SP trusted services
  ⋮
# Delete the credentials and reset the environment, if necessary
if [[ "$nkrb5" != "" ]] then
   /bin/kdestroy >/dev/null 2>&1
   if [[ "$okrb5" != "" ]] then
      export KRB5CCNAME=$okrb5
   else
      unset KRB5CCNAME
   fi
fi
```

Logging in to DCE from a perl Script

The following is an example of using the key file `/home/tom/dcekey` to log in as DCE principal `tom` from within a perl script:

```
/* Get DCE credentials, if DCE authentication is being used */
chop($nkrb5= `/bin/dsrvtgt tom /home/tom/dcekey `);
if($? > 0) {
   print (STDERR "Failed to get DCE credentials\n");
   exit(1);
}
/* dsrvtgt produces no output if DCE is not being used for authentication */
if ("$nkrb5" ne "") {
   $okrb5 = $ENV('KRB5CCNAME');
   $ENV{'KRB5CCNAME'} = $nkrb5;
}
  ⋮
/* Use AIX remote commands or trusted services */
  ⋮
/* Delete DCE credentials and reset environment if necessary */
if ("$nkrb5" ne "") {
    `/bin/kdestroy > /dev/null `;
   if ("$okrb5" ne "") {
      $ENV('KRB5CCNAME') = $okrb5;
   } else {
      delete $ENV{'KRB5CCNAME'};
   }
}
```

Logging in to DCE from a Tcl Script

The following is an example of using the key file `/home/tom/dcekey` to log in as DCE principal `tom` from within a Tcl script:

```
# Get DCE credentials, if DCE is being used for authentication
set rc [catch {exec /bin/dsrvtgt dce-user-name dce-key-file} nkrb5]
if { $rc != 0 } {
   puts stderr "$nkrb5"
   error "Failed to get DCE credentials"
}

# dsrvtgt produces no output if DCE is not being used for authentication
if {"$nkrb5" != "" } {
   set k5env [catch {set okrb5 $env(KRB5CCNAME)}]
   set env(KRB5CCNAME) $nkrb5
}
  ⋮
# Use AIX remote commands or SP trusted services
  ⋮
# Delete the credentials and reset the environment, if necessary
if {"$nkrb5" != "" } {
   catch {exec /bin/kdestroy}
   if {"$okrb5" != ""} {
      set env(KRB5CCNAME) $okrb5
   } else {
      unset env(KRB5CCNAME)
   }
}
```

Obtaining Kerberos V4 Authentication Credentials within Scripts

This section describes how a script running noninteractively, such as from a crontab entry, can establish an identity as an authorized user of SP trusted services or AIX remote commands.

Creating a Kerberos V4 Key File

There are several steps involved in creating a Kerberos V4 key file:

- The Kerberos V4 administrator must create a principal which has an instance part (*k4user.k4instance@k4realm*).
- The root user on the Kerberos V4 authentication server host must use the **ext_srvtab** command to extract the user's key from the database and create the key file named *k4instance* `-new-srvtab` in the current directory:

  `ext_srvtab -n` *k4instance*

- The root user must change the file ownership to the user, using the **chown** command, and move or copy it to *k4keyfilepath* where *k4user* expects to find it.

Logging in to Kerberos V4 from a ksh Script

The following is an example of how to log in to Kerberos V4 from a **ksh** script, where *k4keyfilepath* is `/home/tom/k4key`, *k4user* is `tom`, *k4instance* is `operator`, and the user principal is `tom.operator`:

```
# Get Kerberos V4 credentials, if Kerberos V4 is being used for authentication
okrb4=$KRBTKFILE
export KRBTKFILE=/tmp/tkt$$
/bin/ksrvtgt tom operator /home/tom/key
if [[ $? -ne 0 ]] then
   print "Failed to get Kerberos V4 credentials"
   exit 1
fi
  ⋮
# Use AIX remote commands or trusted services
  ⋮
# Delete the credentials and reset the environment, if necessary
/bin/k4destroy 1>/dev/null
if [[ "$okrb4" != "" ]]
then KRBTKFILE=$okrb4
else unset KRBTKFILE
fi
```

Logging in to Kerberos V4 from a perl Script

The following is an example of how to log in to Kerberos V4 from a **perl** script, where *k4keyfilepath* is `/home/tom/k4key`, *k4user* is `tom`, *k4instance* is `operator`, and the user principal is `tom.operator`:

```
/* Get Kerberos V4 credentials, if Kerberos V4 authentication is being used */
$okrb4 = $ENV('KRBTKFILE');
$ENV{'KRB5CCNAME'} = "/tmp/tkt$$";
 `/bin/ksrvtgt tom operator /home/tom/key `;
if($? > 0) {
   print (STDERR "Failed to get Kerberos V4 credentials\n");
   exit(1);
}
  ⋮
/* Use AIX remote commands or SP trusted services */
  ⋮
/* Delete Kerberos V4 credentials and reset environment if necessary*/
 `/bin/k4destroy 1>/dev/null `;
if ("$okrb4" != "") {
   $ENV('KRBTKFILE') = $okrb4;
} else {
   delete $ENV{'KRBTKFILE'};
}
```

Logging in to Kerberos V4 from a Tcl Script

The following is an example of how to log in to Kerberos V4 from a **tcl** script, where *k4keyfilepath* is `/home/tom/k4key`, *k4user* is `tom`, *k4instance* is `operator`, and the user principal is `tom.operator`

```
# Get Kerberos V4 credentials, if Kerberos V4 is being used for authentication
set k4env [catch {set okrb4 $env(KRBTKFILE)}]
set env(KRBTKFILE) "/tmp/tktvsd.[pid]"
set rc [catch {exec /bin/ksrvtgt tom operator /home/tom/k4key} nkrb4]
if { $rc != 0 } {
   puts stderr "$nkrb4"
   error "Failed to get Kerberos V4 credentials"
}
set nkrb4 [catch {exec /bin/k4list -t}]
  ⋮
# Use AIX remote commands or trusted services
  ⋮
# Delete the credentials and reset the environment if necessary
if { $nkrb4 == 0 } {
   catch {exec /bin/k4destroy}
}
if { $k4env == 0 } {
   set env(KRBTKFILE) $okrb4
} else {
   unset env(KRBTKFILE)
}
```

Displaying Your DCE Credentials

Use the **klist** command. See the book *IBM DCE Version 3.1 for AIX: Administration Commands Reference*.

Displaying Your Kerberos V4 Credentials

This section describes how to see your Kerberos V4 authentication credentials.

With PSSP Authentication

Use the **k4list** command to display a list of currently held authentication tickets and their expiration time. The output would appear like the following, for example, if the user **ben** enters the **k4list** command after using the **k4init** command followed by any of the remote command services on four other hosts:

```
Ticket file:    /tmp/tkt12763
Principal:  ben@XYZ.ABC.COM

  Issued           Expires          Principal
Aug 12 16:26:11  Sep 11 16:26:11  krbtgt.XYZ.ABC.COM@XYZ.ABC.COM
Aug 12 16:45:15  Sep 11 16:45:15  rcmd.spcwkst@XYZ.ABC.COM
Aug 15 09:02:42  Sep 14 09:02:42  rcmd.spnode3@XYZ.ABC.COM
Aug 15 09:02:43  Sep 14 09:02:43  rcmd.spnode5@XYZ.ABC.COM
Aug 15 09:02:43  Sep 14 09:02:43  rcmd.spnode6@XYZ.ABC.COM
```

With AFS Authentication

You may also use the **k4list** command to display tickets obtained from an AFS authentication server. The format of the output is the same as shown above, except that a service ticket for the “afs” service will appear, if you used the AFS **klog.krb** command to identify yourself. This additional service ticket is not used by SP authentication services. As an AFS user, you may prefer to use the **tokens.krb** command to display your tickets. Its output will appear like:

```
Tokens held by the Cache Manager:

User's (AFS ID 12763) tokens for afs@afs.abc.com [Expires May 31 03:24]
User ben's tokens for krbtgt.AFS.ABC.COM@afs.abc.com [Expires Jun 25 19:49]
User ben's tokens for rcmd.wksta2@afs.abc.com [Expires Jun 25 19:50]
   --End of list--
```

Notice that **tokens.klog** shows the AFS cell name in place of the Kerberos V4 realm name.

Deleting Your DCE Credentials

Use the **kdestroy** command. See the book *IBM DCE Version 3.1 for AIX: Administration Commands Reference*.

Deleting Your Kerberos V4 Credentials

This section describes how to delete your Kerberos V4 credentials.

With PSSP Authentication

Use the **k4destroy** command to destroy Kerberos V4 tickets in the current ticket cache file. Depending on your local security policy, you may want to destroy your tickets whenever you end your AIX login session. **k4destroy** overwrites the ticket cache file with nulls before removing the file, so storage containing credentials cannot be reused. When you enter this command, the system will respond:

```
Tickets destroyed.
```

If the ticket cache file does not exist, you will get the response:

```
No tickets destroyed.
```

With AFS Authentication

You may also use the **k4destroy** command to delete tickets obtained from an AFS authentication server and stored in a ticket cache file. The responses are the same as shown previously. **k4destroy** will not remove the token held by the AFS Cache Manager, however, that was also obtained if you used **klog.krb** instead of **k4init** to obtain your initial ticket.

The AFS **unlog** command will remove your tokens held by the AFS Cache Manager, but will not remove tickets from the Kerberos V4 ticket cache file.

Changing Your DCE Authentication Password

If you are using integrated login, use the **passwd** command. Otherwise, use the **dce_login** command. See the book *IBM DCE Version 3.1 for AIX: Administration Commands Reference*.

Changing Your Kerberos V4 Authentication Password

With PSSP Authentication

To change your password, use the **kpasswd** command:

1. Enter the **kpasswd** command:
2. At the prompt, enter your old password
3. At the prompt, enter your new password
4. At the prompt, reenter your new password

For example:

```
kpasswd
Old password for ben:
New Password for ben:
Verifying, please re-enter New Password for ben:
Password changed.
```

With AFS Authentication

To change a password for a principal in AFS:

1. Enter the AFS **kpasswd** command. Be sure you have the directory for the AFS commands, **/usr/afsws/bin** ahead of the directory path for the Kerberos V4 command, **/usr/kerberos/bin** in your search order, or specify the full path name:
2. At the prompt, enter your old AFS password
3. At the prompt, enter your new password
4. At the prompt, reenter your new password to verify

For example:

```
kpasswd
Changing password for 'ben' in cell 'abc.com'
Old password:
New password (RETURN to abort):
Retype new password:
Password changed.
```

Routine System Administration Tasks

Chapter 4. Starting Up and Shutting Down the SP System

This chapter describes how to start up and shut down nodes on the SP system. It explains how to specify the sequence in which the nodes and subsystems in your system are started up and shut down. It also describes the tools that save you time and effort by operating on all or some of the nodes in your SP system with a single command. These tools include the **cstartup**, **cshutdown**, and **seqfile** commands, plus the files they use to control the sequence of startup or shutdown processing.

This chapter describes the interface that lets you coordinate the shutdown of a subsystem that operates across multiple nodes.

Overview of System Startup and Shutdown

You control the operation of the SP system by issuing commands on the control workstation. Use the **cstartup** command to power on SP nodes and boot the operating system or to reset SP nodes. Use the **cshutdown** command to halt or reboot SP nodes. The success of the command depends on the following factors:

- Being authorized to run the command for the relevant hardware.
- Controlling the sequence of operations involved in the total process.

Being Authorized

You are authorized to use these commands if any of the following are true:

- You are the root user.
- You are not root but you are a member of the AIX **shutdown** group.
- You are not root but you are a member of the AIX **cshut** group and you have hardmon virtual front operator panel (VFOP) authority for all of the hardware units involved.

Controlling the Sequence of Startup and Shutdown Operations

Your SP might be a complex group of nodes, each dependent on other nodes for some resources. Startup and shutdown operations must occur in the proper sequence so that these dependencies are honored. As a simple example, a server node might have to be running before its client nodes are started up. A server node should not shut down before its clients have been shut down. The **seqfile** command defines sequencing relationships that result from using boot/install servers. You can define additional dependencies.

To provide best performance, **cstartup** and **cshutdown** can operate on multiple nodes concurrently.

Note: Given appropriate time-out values, the **cstartup** and **cshutdown** commands, properly handle any SP Expansion I/O Units that are connected to POWER3 SMP high nodes.

Similar considerations apply to the shutdown of *special subsystems* (see "Creating a Special Subsystem" on page 94) that run on multiple nodes in the SP system. An example of a subsystem is a file system that spans several nodes within a system partition. Subsystems might need to do special processing to prepare for the shutdown of one or more nodes, or a set of subsystems might need to shut down in a specific order.

You must define the sequencing relationships between your nodes. For example, boot/install servers must start up before their clients. Other programs on your SP system might create additional sequencing relationships.

The node sequence files, **/etc/cshutSeq** and **/etc/cstartSeq**, have lines that describe these dependencies. In these files, you define the groups of nodes and the sequence in which the groups are started up or shut down. If you don't have a node sequence file, some sequencing is performed automatically. The **seqfile** command helps you create these files by generating definitions for groups of nodes and their sequencing order for dependencies relating to boot/install servers and their clients.

You can also create a subsystem sequence file, **/etc/subsysSeq**, which lists the subsystems, defines groups of subsystems, and defines relationships between subsystems. If you don't have a subsystem sequence file, no subsystems are notified of an impending node shutdown.

The sequence files, which reside on the control workstation, are:

/etc/cstartSeq	Startup. The list defining groups of nodes and the order of startup processing.
/etc/cshutSeq	Shutdown. The list defining groups of nodes and the order of shutdown processing.
/etc/subsysSeq	Special subsystems. The list defining special subsystems, groups of special subsystems, and the order of shutdown processing.

The node sequence files are separate to allow for different startup and shutdown dependencies. However, if your startup and shutdown dependencies are mirror images, you can maintain a single file; create a symbolic link to provide both file names.

"Defining Startup and Shutdown Sequence Files" on page 91 describes the format of the sequence files and their interactions with command line flags.

Default Node Sequencing

The SP system can do some sequencing automatically during system startup or shutdown. The **seqfile** command shows you the default sequencing relationships.

If you don't create the **/etc/cstartSeq** file, the **cstartup** command uses a default sequence based on the SDR. Any nodes defined in the SDR as boot/install servers are started up concurrently. After the servers are running, nodes defined as boot/install clients are started up. If you create an empty **/etc/cstartSeq** file, then all nodes are started up concurrently.

If you don't create an **/etc/cshutSeq** file, **cshutdown** uses a default sequence based on the SDR. If you create an empty **/etc/cshutSeq** file, then all nodes are shut down concurrently. If you don't have a **/etc/subsysSeq** file or the file is empty, no special subsystem shutdown occurs.

Starting the SP System

To start the SP system, log in to the control workstation. With authorization for the frames to be started up and the suitable credentials for remote commands and SP trusted services, use the **cstartup** command.

Note for High Nodes and SP-attached Servers

High nodes, and SP-attached servers like the S80, take a considerably longer time to power on than thin and wide nodes, depending on the number of processors in the node and the number of adapters. After you have experienced the amount of time your nodes take, you can better estimate the amount of time to specify with the -W flag for the **cstartup** command.

There might be times when you need to control the startup of these nodes manually, rather than with the **cstartup** command. When you do, be very careful of the sequencing that is otherwise automatically handled.

For a POWER3 SMP high node with SP Expansion I/O Units in particular, the following additional considerations apply:

- Since SP Expansion I/O Units do not have to be in the same frame as the nodes to which they are connected, be sure you have authorization for each frame that is involved.
- If you do not use the **cstartup** command or other equivalent PSSP function, first power on the SP Expansion I/O Units, then reboot or power on and startup the node to which they are connected.

The **cstartup** command powers on specified nodes that are not powered on, and might reset specified nodes that are already powered on. Those actions are equivalent to manually pressing the hardware switches. Once the hardware-equivalent actions are done, control is passed to **boot** and **init**.

Caution!

The **cstartup** command attempts to power on nodes that are powered off. This has safety implications if someone is working on the nodes. Take proper precautions when using this command.

To restart an SP system that is already running, use **cshutdown -r -G**.

Note: If some nodes cannot be started in a specific sequence, or if some cannot be started, the system might still be usable.

The complete syntax of the **cstartup** command is described in the *PSSP: Command and Technical Reference*.

Starting or Resetting All Nodes

You can start or reset nodes with a single **cstartup** command, as shown in Table 3.

Table 3. Specifying Nodes to Start with cstartup

Command	**Meaning**
cstartup ALL	Starts all nodes in the current system partition.
cstartup *target_nodes*	Starts specific nodes in the current system partition. All nodes listed must be in the current system partition or the command will fail.
cstartup -G ALL	Starts all nodes in the physical SP system.
cstartup -G *target_nodes*	Starts specific nodes in the physical SP system, regardless of system partitioning.

If a node is powered off, the **cstartup** command powers it on. If the node is already powered on and is not running, this command resets it. The nodes are started in the sequence specified by **/etc/cstartSeq**. If that file doesn't exist, the nodes are started up in the default sequence.

To start all nodes in the SP system concurrently, ignoring the sequence file if it exists or bypassing the default sequencing if the file does not exist, use the **-E** flag, as in the following example:

```
cstartup -E -G ALL
```

To create the **/etc/cstartSeq** file, see "Defining Startup and Shutdown Sequence Files" on page 91.

Starting or Resetting Selected Nodes

To start or reset a specific node within the current system partition, put its name on the **cstartup** command line. The following example starts the single node in the current system partition named **cs6**:

```
cstartup cs6
```

The command checks for dependencies before starting up the node. It uses the **/etc/cstartSeq** file, if one exists, or the default sequence rules.

If node **cs6** is already running, you must specify either **-z** or **-Z** to force the node to be reset. This example resets the node **cs6** in the current system partition without checking any sequencing dependencies that **cs6** has with other nodes:

```
cstartup -Z cs6
```

You can also identify nodes by node number or range of node numbers using the **-N** flag. The following command starts node numbers 4 through 12 in the current system partition.

```
cstartup -N 4-12
```

Shutting Down the SP System

To shut down the SP system, log in to the control workstation. With authorization for the frames to be shut down and the suitable credentials for remote commands and SP trusted services, use the **cshutdown** command.

Note for High Nodes and SP-attached Servers

High nodes, and SP-attached servers like the S80, take a considerably longer time to power off than thin and wide nodes, depending on the number of processors in the node and the number of adapters. A fully configured POWER3 SMP high node can take even longer. After you have experienced the amount of time your nodes take, you can better estimate the amount of time to specify with the -W flag for the **cshutdown** command.

There might be times when you need to control the shutdown of these nodes manually, rather than with the **cshutdown** command. When you do, be very careful of the sequencing that is otherwise automatically handled.

For a POWER3 SMP high node with SP Expansion I/O Units in particular, the following additional considerations apply:

- Since SP Expansion I/O Units do not have to be in the same frame as the nodes to which they are connected, be sure you have authorization for each frame that is involved.
- If you do not use the **cshutdown** command or other equivalent PSSP function, first shutdown the nodes, then power off the SP Expansion I/O Units that are connected to them.

The SP **cshutdown** command is similar to the workstation **shutdown** command, except it has these advantages over using **shutdown** to shut down each node of an SP:

- **cshutdown** provides a single point of control.

  Using one **cshutdown** command on the control workstation, you can shut down all or selected nodes.
- The sequencing of node shutdown and reboot is automated.

  You can use the **/etc/cshutSeq** file to control the order in which nodes are shut down, or you can let the system determine the order based on System Data Repository information about servers and clients.
- Special user-defined subsystems can be notified of impending node shutdown.

  The **/etc/subsysSeq** file lists these special subsystems and describes any sequencing relationships between them.

Note: The **cshutdown** command powers off the node after the **shutdown** process completes.

You can shutdown nodes with a single **cshutdown** command as shown in Table 4 on page 88.

Table 4. Specifying Nodes to Shut Down with cshutdown.

Command	Meaning
cshutdown ALL	Shuts down all nodes in the current system partition.
cshutdown *target_nodes*	Shuts down specific nodes in the current system partition. All nodes listed must be in the current system partition or the command will fail.
cshutdown -G ALL	Shuts down all nodes in the physical SP system.
cshutdown -G *target_nodes*	Shuts down specific nodes in the physical SP system, regardless of system partitioning.

The complete syntax of the **cshutdown** command is described in the *PSSP: Command and Technical Reference*. Understanding how shutdown processing works might help you understand some of the **cshutdown** command's options. See “The Phases of Shutdown Processing” on page 90.

Halting Nodes

You can halt all nodes in the current system partition with one command, using:

```
cshutdown ALL
```

The **-h** (halt) flag is the default; you don't need to use it when you invoke **cshutdown**. The nodes are shut down in the sequence specified by the **/etc/cshutSeq** file. If this file doesn't exist, the nodes are shut down in a default sequence based on the SDR. If the **/etc/subsysSeq** the exists, those subsystem interfaces are invoked during shutdown.

Halting selected nodes is similar. To halt nodes **cs3**, **cs5**, and **cs7** in the current system partition, use the command:

```
cshutdown cs3 cs5 cs7
```

The command checks for dependencies before shutting down the nodes. If the **/etc/cshutSeq** file exists, those rules apply; otherwise, **cshutdown** applies default sequencing rules based on the SDR. If the **/etc/subsysSeq** file exists, those subsystem interfaces are notified of the shutdown of the target nodes.

The subsystem shutdown phase tells special subsystems to terminate their own operations on the target nodes before the node phase shuts down the target nodes. Groups for which the **/etc/subsysSeq** file does not define a sequencing relationship are invoked concurrently. Subsystems not listed in the **/etc/subsysSeq** file are not notified of the pending system shutdown.

Rebooting Nodes

Reboot all nodes in the current system partition by using the **cshutdown** command with the **-r** (reboot) flag:

```
cshutdown -r ALL
```

The target nodes are halted according to the sequencing rules in **/etc/cshutSeq**, and restarted according to the rules in **/etc/cstartSeq**. If these files don't exist, the default sequencing rules are determined at shutdown and startup.

You can control how the system starts during reboot by passing flags to the **cstartup** processor using the **cshutdown** command's **-C** flag. For example, to pass the **-E** flag to tell the **cstartup** processor to ignore the sequence file when rebooting current system partition nodes numbered 4 and 5, use the command:

```
cshutdown -r -C "-E" -N 4-5
```

To pass multiple startup flags, you must escape any space characters in the string. The double quotes in this example (`"-E"`) do that, although they are not strictly required with a single flag.

Rebooting from Maintenance Mode

If you bring a node down to maintenance mode, you must ensure file system integrity before you reboot the node.

The **cshutdown** command, which runs from the control workstation, will be unable to **rsh** to the node to perform the node shutdown phase processing which includes synchronizing the file systems. IBM suggests that you issue the **sync** command three times in succession from the node console before running **cshutdown**. This is especially important if any files were created while the node was in maintenance mode.

To determine which nodes are in maintenance mode, run the **spmon -d** command and look for the combination of **nodePower** on and **hostResponds** no.

Notifying Users of an Impending Shutdown

You probably want to warn your users if nodes are going down, so they can save and stop any work in progress. You can also have a customized *shutdown clean* script to gracefully terminate nonroot user processes. You can create a shell script, on each node where you want it to run, named **/etc/cshut.clean**. Make it an executable that performs the function you want to be processed before the **cshutdown** command terminates nonroot processes.

By default, when you issue a **cshutdown** command, a message is sent to all users who are logged in to the affected nodes, telling them how long they have before shutdown. You can customize the message as well as the time when the system shuts down.

To power off the entire SP system at 9 pm, for instance, issue the following command:

```
cshutdown -T 21:00 -M "All nodes will power off at 9 pm." -G ALL
```

To power off all nodes in the current system partition at 9 pm, issue the following command:

```
cshutdown -T 21:00 -M "All nodes will power off at 9 pm." ALL
```

Suppose you need to do an emergency reboot of the pair of nodes named **cs1** and **cs2** in the current system partition, but want to allow 10 minutes for jobs to complete. You can notify your users and schedule the reboot with this command:

```
cshutdown -r -T 10 -M \
"Reboot on cs1&2 in 10 minutes--don't submit new jobs." cs1 cs2
```

Several processing phases are involved in the **cshutdown** command.

The Phases of Shutdown Processing

The **cshutdown** command process has these phases:

1. Notifying users and terminating nonroot processes
2. Subsystem shutdown
3. Node shutdown
4. Restarting nodes, if requested

Notifying Users and Terminating Nonroot Processes

The message specified with the -M option of the command is sent to all users who are logged in to the target nodes. If a customized shutdown clean script exists on a node (file **/etc/cshut.clean**), it is run. Then user processes that were not started by root and are running on the target nodes are sent a SIGTERM followed, 30 seconds later, by a SIGKILL. The 30 second delay gives user processes that handle SIGTERM a chance to do whatever cleanup is necessary.

Subsystem Shutdown

The subsystem shutdown phase tells special subsystems to terminate their own operations on the target nodes before the node phase shuts down the target nodes. Groups for which **/etc/subsysSeq** doesn't define a sequencing relationship are invoked concurrently. Subsystems not listed in **/etc/subsysSeq** are not notified of the pending system shutdown.

If **cshutdown** is issued without the **-Y** flag and a nonzero (failure) code is returned, you receive a prompt allowing you to continue, to quit, or to start a subshell so that you can check **/var/adm/SPlogs/cs/cshut.***MMDDhhmmss.pid* for messages and refer to the documentation for the subsystem. When you leave the subshell, you are prompted with the same choices.

The subsystem phase of shutdown waits for all subsystems to return before continuing with the node phase. If a subsystem does not return, the **cshutdown** command waits indefinitely. Use the **-W** flag to specify a time-out value.

Node Shutdown

The node phase operates on nodes specified with the **cshutdown** command. The **/etc/cshutSeq** file controls the sequencing of the node phase operation.

Node shutdown has potentially two levels of coordinated concurrent operations:

- More than one group of nodes can be shut down concurrently.
- Within each one of those groups, more than one node can be shut down concurrently.

They are coordinated such that you can specify that one group must wait for the completion of some other specific groups before starting to shut down.

In a halt operation, the node phase applies the standard workstation shutdown on the target nodes. The nodes are halted in the sequence specified in the **/etc/cshutSeq** file, if it exists, or in the default sequence. Nodes not listed in the **/etc/cshutSeq** file might be halted concurrently with any other nodes.

Restarting the Nodes, If Requested

If you request a system reboot with the **-r** flag, the node phase halts the nodes in the sequence specified in **/etc/cshutSeq** and then restarts the nodes consistent with the initialization sequence specified in **/etc/cstartSeq**. If these files do not exist, the default sequence is used. It does not power on any nodes that were powered off when the **cshutdown** command was issued. If you use the **-r** flag, the only nodes powered on during reboot are those powered off during shutdown.

Checking the Status of Startup and Shutdown Requests

Each time you invoke **cstartup** or **cshutdown**, the system creates a log of activities related to that command. The logs contain an entry for the initiation and completion of operations on each node. The log for **cshutdown** includes information about subsystem shutdown operations. These logs are in the directory **/var/adm/SPlogs/cs**. Two types of log files are created:

cstartup	**/var/adm/SPlogs/cs/cstart.***MMDDhhmmss***.***pid*
cshutdown	**/var/adm/SPlogs/cs/cshut.***MMDDhhmmss***.***pid*

The name of each log file contains the date and time that the command was issued, in the format *MMDDhhmmss***.***pid*, where:

MMDDhhmmss	The time stamp.
pid	The process ID of the **cstartup** or **cshutdown** command.

Defining Startup and Shutdown Sequence Files

Relationships between nodes must be defined in the **/etc/cstartSeq** and **/etc/cshutSeq** files. You define groups of nodes in these files. Nodes in the same group are started up or shut down concurrently. You also define the order in which groups of nodes are processed. Sequencing files can contain nodes from any and all system partitions; sequencing rules are applied without regard to system partitions. Groups without specified sequencing relationships are started up concurrently. Nodes not listed in **/etc/cstartSeq** might be started up concurrently with any other nodes. Nodes not listed in **/etc/cshutSeq** might be shut down concurrently with any other nodes.

The sequencing of special subsystems is handled similarly. Subsystems and groups of subsystems are defined in the **/etc/subsysSeq** file. Subsystems without specified sequencing relationships are shut down concurrently. Subsystems must be defined in this file. If they are not defined, they are not invoked during shutdown.

Planning for Concurrent Startup and Shutdown

It's important that you allow the **cstartup** and **cshutdown** commands to do as much work as possible concurrently. This ensures optimal performance when starting up and shutting down a system with many nodes and/or subsystems. There are potentially two levels of coordinated concurrent operations:

- More than one group of nodes or subsystems can be started up or shut down concurrently.
- Within each one of those groups, more than one node or subsystem can be started up or shut down concurrently.

They are coordinated such that you can specify that one group must wait for the completion of some other specific groups before being started up or shut down.

Format Rules for Sequence Files

A line in **/etc/cstartSeq**, **/etc/cshutSeq**, and **/etc/subsysSeq** can be one of the following:

- Comment line starting with a pound sign (#). A comment can also start within a line.
- Group definition line containing a group name followed by a colon (:), followed by one or more node names (**/etc/cstartSeq**, **/etc/cshutSeq**) or subsystem names (**/etc/subsysSeq**). To put multiple nodes or subsystems in a group, separate their names with commas (,) and, optionally, blanks.
  - In **/etc/cstartSeq** and **/etc/cshutSeq**, a node name is the en0 Ethernet hostname of the node. These are also known as **reliable_hostname** in the **Node** object class in the System Data Repository.
  - In **/etc/subsysSeq**, a group definition line is the arbitrary subsystem group name, followed by a colon (:), followed by the full path name of the command you want issued at shutdown.

  The group names in the file are arbitrary names and treated as tokens.

  Each node or subsystem can be in only one group. A group can consist of from 1 to all your nodes or subsystems.
- Sequence line containing a greater than symbol (>). For instance, in the **/etc/cstartSeq** file, `groupA > groupB` says to start groupA before starting groupB. And, in the **/etc/cshutSeq**file, `groupA > groupB` says to shut down groupB before shutting down groupA.

  A group cannot both precede and trail the same group. That is, the sequence `A > B > A` is not valid.

The lines can be in any order. Each node must be assigned to a group if you wish to control its sequencing.

A group or node name cannot contain a blank, comma, new line, tab, greater than (>), colon (:), parentheses (), or pound (#) character. Case is significant in node and group names.

Testing Your Sequence Files

You can verify that the **/etc/cstartSeq** file has the correct format without powering on or resetting any nodes by specifying:

```
cstartup -k ALL
```

The **-k** flag tells **cstartup** not to reset any nodes, just check the sequence file. If the sequence file is correct, you'll get the following message:

```
cstartup: No circular dependencies were detected
```

Verify that the **/etc/cshutSeq** and **/etc/subsysSeq** files have the correct format without shutting down any nodes by specifying:

```
cshutdown -kF ALL
```

The **-k** flag tells **cshutdown** not to shutdown any nodes, just check the sequence file. The **-F** flag tells **cshutdown** not to issue any messages to users.

Getting Started: Capturing the Default Sequences

An easy way to create your **/etc/cstartSeq** and **/etc/cshutSeq** files is to capture the default group definitions and sequencing relationships that are based on the boot/install server information in the System Data Repository. You can then add to or modify them as required for your installation.

To create the default **/etc/cstartSeq** file, use the command:

```
seqfile -b > /etc/cstartSeq
```

The **-b** flag tells **seqfile** to include boot/install relationships, which are important only during system startup.

To create the default **/etc/cshutSeq** file, use the command:

```
seqfile > /etc/cshutSeq
```

After you've created the default files, you can edit them to reflect sequencing relationships based on other aspects of your installation's configuration.

Sample Startup File /etc/cstartSeq

Here is a simple file for sequencing startup:

```
ServerA > ClientsOfA
ServerA: node2
ClientsOfA: node3, node4, node5, node6
```

The line `ServerA: node2` defines node 2 as the group ServerA. The line `ClientsOfA: node3, node4, node5, node6` defines nodes 3 through 6 as a group that can be started up concurrently. The sequence line `ServerA > ClientsOfA` says that ServerA must be completely started up before starting up the nodes that are clients of server A (nodes 3 through 6).

This sample file is slightly more complex:

```
groupA > groupB
groupA > (groupF, groupE) > groupD > groupC
groupD > groupG
groupA: node0  #node0 is the node that node1-node7 depend on.
groupB: node1
groupC: node2
groupD: node4
groupE: node5
groupF: node6, node7
groupG: node3
```

The line `groupA > ( groupF, groupE )  > groupD > groupC` says to start up groupA. When groupA is up, concurrently start up groupF and groupE. After they are up, start up groupD. Finally, when groupD is up, start up groupC. The line `groupA > groupB` says that groupB depends on groupA, but can be started concurrently with groupE and groupF. No other groups have dependencies on groupB.

If your command line specifies a node but omits another that is listed in your **/etc/cstartSeq** or **/etc/cshutSeq** files as its leading node, the sequencing rules still apply unless overridden by the **-X** flag.

Sample Shutdown File /etc/cshutSeq

Here is one of the sample startup sequence files, interpreted now as a shutdown file:

```
ServerA > ClientsOfA
ServerA: node2
ClientsOfA: node3, node4, node5, node6
```

The line `ClientsOfA: node3, node4, node5, node6` defines nodes 3 through 6 as a group that can be shut down concurrently. The line `ServerA: node2` defines node2 as the group (of one node) called ServerA. The line `ServerA > ClientsOfA` says that the nodes that are clients of server A (nodes 3 through 6) can be shut down concurrently, but must be shut down before node2 in group ServerA.

Sample Subsystem File /etc/subsysSeq

A sample file for subsystem shutdown could be:

```
ssgroupA: /full/pathname/subsystemA
ssgroupB: /local/subsystemB, /local/subsystemC
ssgroupA > ssgroupB
```

The line `ssgroupA: /full/pathname/subsystemA` defines the group ssgroupA, consisting of the single subsystem invoked by the /full/pathname/subsystemA command. The line `ssgroupB: /local/subsystemB, /local/subsystemC` defines a group consisting of the two subsystems /local/subsystemB and /local/subsystemC.

The line `ssgroupA > ssgroupB` says to first notify ssgroupB before nodes are shut down. When both subsystems in ssgroupB have returned, then notify the single subsystem in ssgroupA.

Creating a Special Subsystem

Read this section if you write your own special subsystem and want the **cshutdown** command to notify the subsystem when nodes are being halted or rebooted. The SP system has no predefined special subsystems.

The special subsystem interface is a user-provided command that is invoked during the subsystem phase of SP system shutdown processing. The command is defined in the **/etc/subsysSeq** file and must reside on all nodes of the SP system; the **cshutdown** command invokes the subsystem interface on a randomly selected node in the current system partition.

The following sections define the interface to a special subsystem. This interface consists of:

- The inputs that the **cshutdown** command passes to your special subsystem
- The actions your subsystem must perform.

Note: The special subsystem interface is called *after* nonroot processes are killed. If you want your subsystem to take advantage of shutdown notification, some part of it must be running as root.

Input to the Special Subsystem Interface

The **cshutdown** command invokes the special subsystem interface with the following standard parameters:

-r or **-h**	Indicates whether the **cshutdown** command is halting (**-h**) or restarting (**-r**) the target nodes.
-b *IPaddress*	Specifies, in dotted decimal form, the IP address of the calling program, in this case, the control workstation.
-f /var/adm/SPlogs/cs/cshut.*MMDDhhmmss***.***pid*	Specifies the log file to which the subsystem interface program should append a record of status and activities.
target_nodes	The list of node numbers of the target nodes specified on the **cshutdown** command line. The numbers are passed at the end of the argument list.

For example, if the **/etc/subsysSeq** file contains the following line:

```
ssgroupA: /full/pathname/subsystemA
```

and this **cshutdown** command is issued on the control workstation whose IP address is 129.40.64.70:

```
cshutdown -h -N 1 2 3
```

the **cshutdown** command issues the following command on a randomly selected node during the subsystem phase of shutdown processing:

```
/full/pathname/subsystemA -h -b 129.40.64.70 \
                           -f /var/adm/SPlogs/cs/cshut.time.pid \
                           1 2 3
```

What Your Special Subsystem Must Do

In addition to any processing specific to the subsystem, the special subsystem must call the **csLogger** command to record its activities. Your program must call **csLogger** with the following required parameters:

-b *IPaddress*	Specifies, in dotted decimal form, the IP address of the calling program, in this case, the control workstation.
-f /var/adm/SPlogs/cs/cshut.*MMDDhhmmss***.***pid*	Specifies the log file to which the subsystem interface program should append a log of status and activities.
logString	Specifies a string that will be appended to the specified log file. This is the last parameter.

Using the example previously started, if the **cshutdown** command calls your program with this command:

```
/full/pathname/subsystemA -h -b 129.40.64.70 \
                           -f /var/adm/SPlogs/cs/cshut.time.pid \
                           1 2 3
```

then the **/full/pathname/subsystemA** command could log the start and completion of subsystem shutdown by making calls similar to these:

```
csLogger -b 129.40.64.70 \
         -f /var/adm/SPlogs/cs/cshut.time.pid \
         subsystemA:  initiating shutdown at 15:43.55 on 1 Apr 99.

csLogger -b 129.40.64.70 \
         -f /var/adm/SPlogs/cs/cshut.time.pid \
         subsystemA:  shutdown complete at 15:46.23 on 1 Apr 99.
```

Chapter 5. Remote Execution of SP Commands

This chapter describes commands provided with the SP system which are useful for performing common tasks on multiple nodes in parallel. These parallel commands, which work cooperatively with AIX authenticated remote commands and the **sysctl** function, facilitate secure management of the SP system from a single point of control.

This chapter discusses the following:

- The AIX authenticated remote commands, some of which are used by PSSP parallel command processes.
- The AIX remote command authorization files that control who can run these commands.
- How to use the PSSP **dsh** command to run parallel management commands.
- The parallel management commands.[1]

Enhanced Security Option:

PSSP 3.2 provides the option of running your SP system with an enhanced level of security. This function removes the dependency PSSP has to internally issue **rsh** and **rcp** commands as a root user from a node. When this function is enabled PSSP does not automatically grant authorization for a root user to issue **rsh** and **rcp** commands from a node. If you enable this option some procedures might not work as documented. For example, to run HACMP an administrator must grant the authorizations for a root user to issue **rsh** and **rcp** commands that PSSP would otherwise grant automatically. See the ITSO Redbook *Exploiting RS/6000 SP Security: Keeping it Safe* for a description of this function and a complete list of limitations.

AIX Authenticated Remote Commands

The AIX authenticated remote commands that you can use for remote management are the following:

rsh	This command executes the specified command at the remote host or logs into the remote host.
rcp	This command transfers files between a local and a remote host or between two remote hosts.
telnet	This command connects the local host with a remote host, using the Telnet interface.
ftp	This command transfers files between a local and a remote host.
rlogin	This command logs into a specified remote host and connects your local terminal to the remote host

[1] The parallel management commands described in this chapter were influenced by, but are not an implementation of, the tools described in Gropp, William and Ewing Lusk. 1994. Scalable UNIX tools on parallel processors. In *Proceedings of the Scalable High Performance Computing Conference*, 56-62. IEEE.

All of these commands support both the DCE and standard AIX authentication methods. In addition, the **rsh** and **rcp** remote commands also support the SP Kerberos V4 authentication method.

The **rcmdtgt** command is provided for applications requiring Kerberos V4 root credentials.

AIX Remote Command Authorization Files

The method of authorizing users for remote command access on a target system depends on the authentication methods used. There is one type of authorization file for each authentication method supported in the SP system. The control workstation and the nodes which are configured for an authorization method maintain their own copy of that method's authorization file. For all methods, access is based on the contents of a file in the target user's home directory:

- DCE – the .k5login file contains a list of authorized Kerberos V5 principal names.
- Kerberos V4 – the .klogin file contains a list of authorized Kerberos V4 principal names. Kerberos V4 is required in partitions that contain nodes with PSSP 3.1 or earlier levels.
- Standard AIX – the .rhosts file contains a list of authorized source host names and user names.

These authorization files for the root users are constructed such that:

- The root user on the control workstation can issue **rsh** as root to every node in the system.
- The root users on a node can issue **rsh** as root to all nodes within all partitions which are configured with any authentication methods in common with that node.

If the authorization files already exist in the root user's home directory when you select the authorization method for the partition, the SP-generated entries will be added to the existing file and the existing authorization files will remain intact.

The root user's authorization files are initially created when one or more authorization methods are chosen for a partition. Whenever new nodes are installed in a partition, nodes are moved from one partition to another partition, configured for a different set of authorization methods, or nodes are removed from the system, the authorization files are automatically updated on:

- The node involved in the move.
- The control workstation and all nodes in all partitions which share common authorization methods with the node's new partition (to add entries for the new node).
- All nodes in all partitions which share common authorization methods with the node's old partition (to remove the node's entries).

Whenever a node boots, the **/etc/rc.sp** command executes on the node and ensures that the node's authorization files are current and the files are updated, if necessary.

See Chapter 2, “Security Features of the SP System” on page 13 if you need more information about security.

Using dsh to Run Parallel Management Commands

You can use the PSSP **dsh** command from a single point of control to execute commands on:

- All nodes in the current system partition (**-a** option)
- All nodes in the SP system (**-aG** option)
- Selected nodes (**-w** option)
- Node groups (**-N** option)

You do not have to limit the target nodes to those nodes on your SP system. The **dsh** command uses the authenticated AIX remote command **rsh**. The **dsh** command can execute commands on any host in your network to which you can issue commands through the AIX authenticated remote command **rsh** (see "AIX Authenticated Remote Commands" on page 97). Using **dsh** rather than an **rsh** loop offers better performance because the commands can run concurrently.

Specifying Input to dsh

The **dsh** command provides several ways for you to specify input:

1. **dsh** reads lines from standard input and executes each line as a command via **rsh**. Specify commands in **rsh** syntax. Pipes, filters, output redirection, and paths can be used on the remote nodes in the same way they are used in **rsh**.

   The following **dsh** command targets three nodes, reads commands from stdin, and filters the output of the **ps** command remotely:

   ```
   $ dsh -w host1,host2,host3
   dsh> ps -ef "|" grep root
   ```

   Note: Any input line beginning with an exclamation point is passed directly to the shell on the local host.

2. **dsh** accepts commands specified on the command line. For example, to issue the **ps** command on three nodes and filter the results remotely, specify:

   ```
   dsh -w host1,host2,host3 ps -ef "|" grep root
   ```

Targeting Nodes for dsh

The **dsh** command sends the included commands to a node set called the **working collective**. The **dsh** process assembles the working collective from the first existence of one of these sources:

1. A list of hostnames you specify on the command line with the **-a**, **-G**, **-w**, **-N** flags.
2. The contents of a file you specify in the **WCOLL** environment variable.

If neither of these exist, an error has occurred and no commands are issued.

You can have commands run on the working collective concurrently or in sequence. Default processing is done concurrently, but you can specify a maximum number of nodes for concurrent execution to prevent system degradation. When this maximum number, or *fan out* is reached, results from outstanding **rsh** commands are awaited before any further commands are run. These **rsh** results are displayed as soon as they return from the remotely executed commands.

This example specifies a maximum of 8 concurrent commands even though the working collective is defined as the entire system partition.

```
dsh -f 8 -a  cat /var/adm/SPlogs/sysman/"*"config.log"*" | pg
```

Note: Because **dsh** starts processes for each host in the working collective, there might be cases where a smaller fan out will result in less contention for resources on the local machine, and thus better overall performance, than the greater concurrence of a larger fan out.

Output from dsh

The **dsh** process displays information, that returned from the commands, grouped by hostname. The stdout data of the remotely executed commands goes to the stdout of the **dsh** command. The stderr of remotely executed commands goes to the stderr of the **dsh** command.

All lines of data in the **dsh** command stderr and stdout results are prefixed by the name of the host that sent them. You can format **dsh** stderr and stdout lines by piping them to the **dshbak** command, which strips off the hostnames and displays the lines grouped by host in alphabetic sequence, as shown in this example:

```
dsh -w host1,host2,host3 cat /etc/passwd 2>&1 | dshbak
```

Another example follows using a group of nodes:

```
dsh -N bis_nodes cat /etc/bootptab 2>&1 | dshbak
```

Alternatively, the **dshbak** command can be specified with the **-c** option. This causes any identical output from two or more nodes to be shown only once, with the hostnames displayed above the output. Remember, however, that the most efficient way to filter large amounts of output from parallel commands is to filter on the nodes before the output is returned to the workstation from which the parallel command was issued.

Error Handling

No special error recovery is provided for the **dsh** command on remote hosts. If **dsh** finds that a node in the working collective is down, no further commands will be sent to that node unless you specify the **-c** (continue) flag on the command line. If hosts are down, the underlying **rsh** command will time out in approximately 2.5 minutes.

The hostlist Command

The **hostlist** command can be used to specify hostnames for parallel command execution by way of the **dsh** or **sysctl** command. The command writes hostnames to stdout based on various criteria:

- The contents of a **dsh** working collective file
- The contents of a POE hostname file
- All the nodes in the current system partition (**-a** option)
- All the nodes in the SP system (**-aG** option)
- Ranges of slots on particular frames
- A set of nodes to exclude
- A range of node numbers
- Explicitly listed hostnames

Before the names are written, there is an optional check of whether the nodes are responding.

The output from **hostlist** can be written to a file, which can then be used as a working collective file for **dsh**. Both **dsh** and **sysctl** can read hostnames from stdin, so the output of **hostlist** can be piped directly to **dsh** or **sysctl**.

Examples

To issue a command to the node in the first slot in each of the first 4 frames:

```
hostlist -s 1-4:1 | dsh -w - command
```

To run the program on the nodes on all slots for frame 1 and on slots 1-3 for frame 3, and also on host **otherone**:

```
hostlist -n 1-16,33-35 -w otherone > /tmp/wcoll
WCOLL=/tmp/wcoll dsh program
```

To determine all the nodes in the SP system on which one is authenticated, and to bypass the nodes that are not responding and “badnode”, issue the command:

```
hostlist -av -e badnode | sysctl -c - -L whoami | dshbak -c
```

Note: The **-L** option on **sysctl** is necessary if the **dshbak** filter is used. It causes the output lines of **sysctl** to be formatted with the hostname preceding each line.

Output might look like this:

```
 HOSTS=============================================================
 host1           host2            host3            host4
 host5           host6            host8
 ==================================================================
 joe.@A.B.C

 HOSTS=============================================================
 host7
 ==================================================================
 unknown
```

If the **-c** option is not specified, output will not be collapsed:

```
HOST: host1
===========
joe.@A.B.C

HOST: host2
===========
joe.@A.B.C
⋮
```

The Parallel Management Commands

The SP system provides several parallel management commands. They all have a common syntax and are based on **dsh**, **sysctl**, **hostlist**, and **dshbak** commands. More complete descriptions of each is provided in the *PSSP: Command and Technical Reference*.

The syntax of the parallel management commands is:

```
command_name
remote_host_specification cmd_args_flags
```

where:

command_name	The name of a parallel command
remote_host_specification	Indicates which hosts the command should be executed on. Can be a range of slots, a list of hostnames, a set of flags to the **hostlist** command, or read from stdin.
cmd_args_flags	The flags and arguments to the command

Where appropriate, the output from the parallel management commands is filtered as described previously.

The following parallel management commands are based on **dsh**.

pexec

This application issues a command in parallel on the specified hosts. Any arguments to the commands are passed along with the command name. Results are filtered as described in "Output from dsh" on page 100. For example, to show which users are logged on nodes in slots 5–8, use the command:

```
pexec 5-8 who
```

pexscr

This application executes commands in parallel on different hosts, including the local host. Unlike **pexec**, the commands might differ on different hosts. Lines consisting of *hostname: command* are read from stdin. When the lines have been read, each command is executed on the corresponding host in parallel. Remote commands are executed via **rsh** and local commands are executed directly. For example, you could create file **/etc/doit** on r05n09 containing the following text:

```
r05n09: /usr/lpp/ssp/rcmd/bin/rcp /tmp/bozoid tserv11:/tmp/bozoid
r05n09: /usr/lpp/ssp/rcmd/bin/rcp /tmp/bozoid r05n01:/tmp/bozoid
r05n01: backup_script
r05n15: backup_script
```

Then, to copy the local file **/tmp/bozoid** to tserv11 and r05n01 and simultaneously start backup scripts on r05n01 and r05n15, issue the command:

```
pexscr < /etc/doit
```

pcp

This command distributes a local file or directory to remote hosts in parallel. It uses the SP authenticated remote command **rcp**. To use this command, you must be authorized to issue commands of the form:

```
rcp localfile
remotehost: remotefile
```

for each of the hosts to which the file is to be copied. To recursively copy **/etc/new/** on the local host to **/etc/new1/** on the host in the first slot of each of the first four frames, use the command:

```
pcp “-s 1-4:1” -r /etc/new/ /etc/new1/
```

p_cat

This application issues the **cat** command in parallel on the specified hosts. Any arguments to the command are passed along with the command name. Results are not filtered. For example, the command

```
p_cat “-w host1,host2,host3” /etc/file > localfile
```

copies the contents of the **/etc/file** files on each of the hosts to the **localfile** file on the local host. **localfile** would consist of unmodified lines from **/etc/file** on **host1**, on **host2**, and on **host3** concatenated together.

pls, pfind, prm, pps, pmv

These commands issue the **ls**, **find**, **rm**, **ps**, or **mv** commands in parallel on the specified hosts. Any arguments to the AIX commands are passed along with the command name. Results are filtered. For example,

```
pls “-av -e badnode” /
```

lists the contents of the root directory on all the responding hosts in the SP system with the exception of “badnode”. Note that the **-i** flags to **mv** and **rm** are not supported because **dsh** doesn't propagate the **stdin** of the remote hosts.

Examples

For example, a working collective could be set up with **hostlist**:

```
hostlist -av > /tmp/wcoll
export WCOLL=/tmp/wcoll

pps “” -ef
```

would list information about all the processes on the nodes in the working collective.

```
pfind “” /usr/lpp/ssp/bin/  -name “pfind” -print
```

might result in the following:

```
HOSTS =========================================================================
r05n01             r05n03dx           r05n05             r05n07
r05n09             r05n10             r05n13             r05n14dx
r05n15             r05n16
 ===============================================================================
 /usr/lpp/ssp/bin/pfind

pmv “” /tmp/foo /tmp/newfoo
```

would rename **/tmp/foo** on all the working collective.

```
pls “” /tmp/\\*foo
```

could result in the following output:

```
HOSTS =========================================================================
r05n01             r05n03dx           r05n05             r05n07
r05n09             r05n10             r05n13             r05n14dx
r05n15             r05n16
===============================================================================
/tmp/newfoo
```

Note that the shell metacharacter is escaped twice, once to protect it from the shell, and once to protect it when the **rsh**'s are done by **dsh**.

```
prm "" /tmp/newfoo
```

would remove **/tmp/newfoo** from all the nodes in the working collective.

ppred

This application issues a **ksh** test on each node in parallel and runs commands based on the results of the test. For example,

```
ppred 1-16 '-f /etc/foo' 'echo Here' 'echo Not here'
```

could result in output like the following:

```
HOSTS=============================================================
host1            host2             host3            host4
host5            host6             host8
==================================================================
Here

HOSTS=============================================================
host7            host9             host10           host11
host12           host13            host14           host15
host16
==================================================================
Not here
```

pfps

pfps is a parallel process find application. It takes arguments similar to those of the **find** command, but operates on processes instead of files. In addition, access control list-based permissions to **nice** or **kill** processes is provided. For example, to signal all the “daemond” processes in the SP system partition in parallel, a user that was in the **/etc/sysctl.pfps.acl** file on each node could issue the following:

```
pfps "-a" -tn sysctld -kill HUP
```

For example, to list the **sysctl** daemon processes on nodes **r05n15** and **r05n16**, use the command:

```
pfps "-w r05n15,r05n16" -tn sysctld -print
```

The output is similar to the following:

```
HOSTS ==========================================================================
r05n15
================================================================================
USER       PID %CPU %MEM   SZ  RSS    TTY STAT    STIME  TIME COMMAND
root     11172  0.0  1.0  452  420      - S    11:54:47  0:00
/usr/lpp/ssp/bin/sysctld -l /var/adm/SPlogs/sysctl/sysctld.log
root     12497  0.0  1.0  300  360      - S    06:24:19  0:00
/usr/lpp/ssp/bin/sysctld -l /var/adm/SPlogs/sysctl/sysctld.log

HOSTS ==========================================================================
r05n16
================================================================================
USER       PID %CPU %MEM   SZ  RSS    TTY STAT    STIME  TIME COMMAND
root      7089  0.0  1.0  448  420      - S    11:54:48  0:00
/usr/lpp/ssp/bin/sysctld -l /var/adm/SPlogs/sysctl/sysctld.log
root      8423  0.0  1.0  296  360      - S    13:01:31  0:00
/usr/lpp/ssp/bin/sysctld -l /var/adm/SPlogs/sysctl/sysctld.log
root     10418  0.0  1.0  512  504      - S
```

pdf

pdf is a parallel command that performs function similar to **df**. It provides more information than the **df** command. To get file system information from all the nodes on the first slots of each of four frames, use the commands:

```
hostlist -s 1:1-4 > /tmp/wcoll
export WCOLL=/tmp/wcoll
pdf “”
```

To find information on the **/var** filesystem on the nodes in the working collective, use the command:

```
pdf “” /var
```

The output is similar to the following:

```
Filesystem             Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
===================    ======= ======= ======= =====  =====  ===== ======
HOST: r05n01
============
/var                      8192    2452    5740   71%    279   1769    87%

HOST: r05n03dx
==============
/var                      8192    1988    6204   76%    214   1834    90%

HOST: r05n05
============
/var                      8192    2080    6112   75%    223   1825    90%

HOST: r05n07
============
/var                      8192    2080    6112   75%    223   1825    90%

HOST: r05n09
============
/var                      8192    2088    6104   75%    223   1825    90%

HOST: r05n10
============
/var                      8192    2448    5744   71%    286   1762    87%

HOST: r05n13
============
/var                      8192    2220    5972   73%    229   1819    89%

HOST: r05n14dx
==============
/var                      8192    2012    6180   76%    221   1827     90%

HOST: r05n15
============
/var                      8192    2368    5824   72%    220   1828    90%

HOST: r05n16
============
/var                      8192    2100    6092   75%    225   1823    90%
```

pfck

pfck displays file system information in parallel based on various usage criteria. For example, to find information on all the file systems on the hosts in POE host list file **hostlist** that have used more than 100000 KB, use the command:

```
MP_HOSTFILE=./hostlist pfps "" -s 100000
```

To display the filesystems on hosts **r05n16** and **r05n15** that have more than 90% of their space used, use the command:

```
pfck "-w r05n15,r05n16" -pu 90
```

The output is similar to the following:

```
Filesystem                 Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
===================        ======= ======= ======= =====  =====  ===== ======
HOST: r05n15
============
/usr                        331776  327640    4136    2%  17673  66295    79%

HOST: r05n16
============
/usr                        331776  327640    4136    2%  17673  66295     79%
```

To find all the **/var** file sytems in the SP system that are 95% full, use the command:

```
pfck “” -pu 95 | egrep “(var|HOST)”
```

The output is similar to the following:

```
Filesystem                 Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
===================        ======= ======= ======= =====  =====  ===== ======
HOST: r05n10
/var                        335872  331412    4460    2%  17819  66149    79%
HOST: r05n13
/var                        335872  331632    4240    2%  17820  66148    79%
HOST: r05n14dx
/var                        335872  331388    4484    2%  17817  66151    79%
```

Chapter 6. Controlling Remote Execution by using Sysctl

Sysctl is an authenticated client-server system for running commands remotely and in parallel. It provides:

- **Least privilege capability**

  Root authority can be dynamically provided to non-root users based on their authenticated identity, the task they are trying to perform, access control lists, and any other relevant criteria. The root password need not be given out to as many people, and thus is kept secure.

- **Distributed execution**

  Sysctl applications can be executed on remote hosts with full authentication and authorization. It is essentially a secure, easy-to-program remote command execution mechanism for AIX commands, scripts and programs.

- **Parallel execution**

  Sysctl applications can be efficiently executed in parallel on many hosts.

- **Programmability**

  Sysctl applications can be coded as scripts for ease of implementation.

For example, consider a systems management script that contains commands that are only executable by root. If implemented as a Sysctl application, its security, usability, and performance are enhanced. Least privilege capability lets a member of a select group of administrators run the script on each node in the SP system without having access to the root password on any node in the system. With distributed execution, the administrator does not have to log in to each node to run the script. With parallel execution, the script can be run on all the nodes simultaneously with one command invocation. With programmability, the task can be automated or simplified with scripting.

Components of Sysctl

Sysctl contains the following components:

- A server daemon (**sysctld**) that runs on all nodes and the control workstation.

  This server daemon has root privileges. It executes commands as root on behalf of authorized clients.

- Built-in commands.

  These commands that are built into the server do the actual system administration work. Each command is paired with an authorization-checking script, referred to as a *callback*, that has access to authenticated information about the client attempting to run the command. These commands include IBM-provided commands and typically also include installation-written ones.

- Configuration files that control aspects of the server operation as well as extend the command set available on a given node.
- Access control lists that list authorized users.
- A client program (**sysctl**) that offers command-line and interactive interfaces for communicating with **sysctld** servers.

Figure 2 on page 110 illustrates how the Sysctl elements interact.

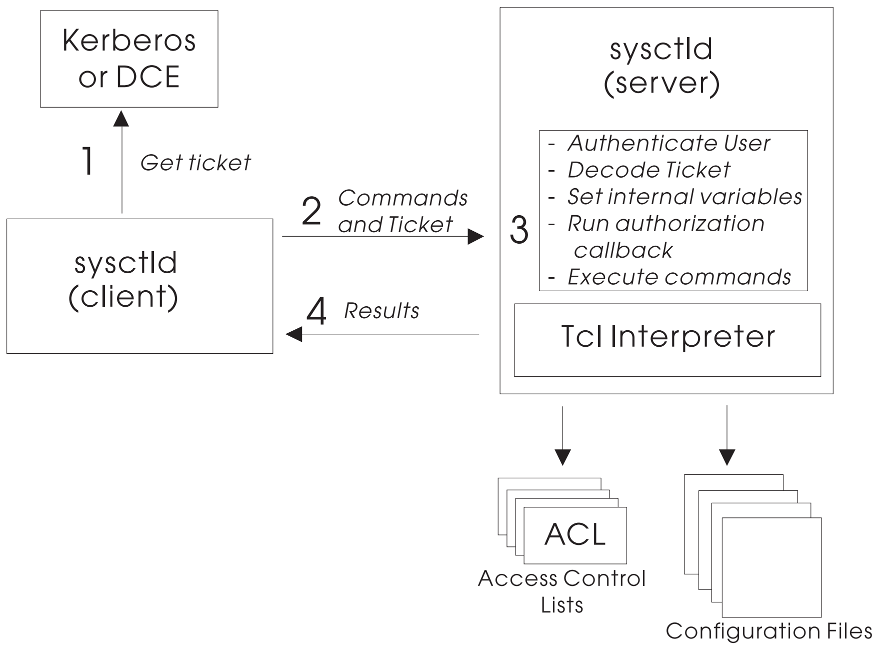


Figure 2. Sysctl Elements

The interpretation of a Sysctl command starts when the user issues a Sysctl client command. This can be embedded in a script or issued directly from the command line. It is of the following form:

```
sysctl target_nodes_specification
command args
```

More than one node can be targeted. The command is the name of a Sysctl server command to be run as root on each of the targeted servers, if the client user is authorized. The following steps are performed:

1. The Sysctl client code obtains authentication information about the command issuer from SP security services.
2. The Sysctl client code sends the authentication information, along with the command string, to each of the specified Sysctl servers in parallel.
3. Each server then performs the following steps:
   a. The authentication information is decoded and the authenticated information about the client, known as credentials, is obtained.
   b. Internal variables, such as the user name and the host of the client are set. These variables are available to the server routines, known as the authorization callbacks, that will check the authorization of the client as well as the Sysctl commands to be run.
   c. The authorization is checked via an authorization callback. This can be a supplied callback, or an installation-written one. This callback may check an ACL. If the client passes the authentication check, the next step is done.
   d. The server commands requested are executed as root, on behalf of the client.

4. **stdout** and **stderr** are sent back to the client. Output from each server is displayed with labeling indicating its source.

Relationship to the SP Security Services

The SP system administrator chooses the level of security services to use on the control workstation and nodes in each SP system partition and on individual workstations. The options are typically set during installation and configuration or during migration and configuration, based on the security policy of your organization. An authorized administrator can change which of the installed and configured authentication methods are enabled within an SP system partition at any time.

Sysctl uses the SP security services. The security characteristics of the Sysclt facility depend on the way security services are configured within the SP system partition in which Sysctl is operating at the time. If an authentication method is used, it is provided either by the DCE security services, or by the SP implementation of Kerberos V4.

The SP security services determine which authentication method is applicable from the security configuration information on the client and server hosts, and by the way users obtain credentials. A security administrator creates principals for users and establishes the procedures for obtaining credentials: either automatically at AIX login or by an explicit command.

Sysctl allows any client request to be submitted with or without authentication. Whether access is granted is a matter for the authorization policy established on your SP system and enforced by the SP security services. Authenticated users can be DCE principals or Kerberos V4 principals. Authenticated users need to identify themselves to the authentication service. With DCE, this generally happens automatically when the user logs in to AIX. If the integrated DCE and AIX login feature is not used on your SP system, you must use the **dce_login** command before using Sysctl facilities that require an authenticated identity. On hosts that use Kerberos V4 when the compatibility authentication method is active, users can obtain credentials at AIX login, but only by entering their Kerberos V4 password separately after the AIX password prompt. Users who do not already have Kerberos V4 credentials must issue the **k4init** command before using Sysctl facilities.

See Chapter 2, “Security Features of the SP System” on page 13 for more information on security services.

Overview

Architecture

A Sysctl server provides remote access to a set of commands for authenticated and authorized clients. Since the Sysctl server is running with UID 0, these commands are executed with root privilege. These commands are embedded in an interpreter within the server. Sysctl uses the Tool Command Language (Tcl) as the foundation for its built-in command interpreter. The commands are of the following types:

- Base Tcl commands.

  These are the commands making up the Tcl language. They include control commands (such as **if**), input/output commands (such as **puts**), arithmetic commands (such as **expr**) and commands allowing the execution of other commands, including external AIX commands and scripts (**exec**).

- Built-in Sysctl commands.

  These are provided for you. They include commands to configure and manage Sysctl, as well as some systems management applications. See "Built-in Sysctl Commands" on page 135.

- Your applications.

The Tcl interpreter that Sysctl uses is built from base Tcl and Extended Tcl. Refer to the **ssp.public.README** file for more information on Tcl as supplied with the SP.

Using an embedded language, particularly Tcl, provides the following advantages:

- The command language interface is ideal for administrative tasks.
- The Sysctl command set is extended by writing Tcl scripts (instead of C code). These new Tcl scripts are embedded in the server's command set.
- Users can write simple Tcl wrappers for Perl and shell scripts and then add the scripts to the server command set.
- The Sysctl authentication mechanism gives the administrator complete control over the set of commands available to a given set of users. (see Chapter 2, "Security Features of the SP System" on page 13).

Security

The management tools used to administer a large site need to be secure to prevent outside intrusion and to prevent accidental disasters, such as inadvertently deleting critical data.

Sysctl has the following security components:

- Access Control Lists
- Client authentication
- Identification and authentication
- Authorization callbacks

Access Control Lists (ACLs)

An ACL is a text file that can be used to grant authority to particular users to issue particular commands. Sysctl provides ACL-based authorization. See "Sysctl Files" on page 117 for more information.

Client Authentication

The security services supported on the SP system provide trusted third party authentication of users. When a client issues a Sysctl command, client credentials are sent along with the command. The server uses that information to identify and authenticate the identity of the client.

Identification and Authentication

Identification and authentication are procedures that a client and server use to verify their identities to each other. The objective is to provide an identity that the server can use for authorization. The way that identification and authentication take place is determined by the security policy established by your organization and implemented by the SP system and security administrators, as well as by the actions taken or not taken by an individual user. SP systems running PSSP 3.2 can be configured to support any of the following combinations of authentication methods for SP trusted services:

dce
compat
dce and compat
none

When one or both authentication methods is used for SP trusted services, as an authorized administrator, you must create principals in the authentication database to represent the clients. For the purpose of authentication, a client command uses the principal name of the user who is running it. Servers use service principal names that are predefined during system configuration. To establish how users obtain credentials so they can submit Sysctl requests as authenticated clients, do the following:

- If using DCE, use the DCE and AIX integrated login feature. It automatically obtains DCE credentials when a user logs in to the local AIX system.
- If using Kerberos V4, see "Integrating Login For Kerberos V4 with AIX" on page 42.

A user of the Sysctl facility can submit requests for remote execution as an unauthenticated AIX user or as an authenticated principal. The Sysctl client command obtains and forwards to the target server, the AIX user name that submitted the command as an unauthenticated identity, plus whatever authentication credentials are available. The client might have a DCE identity, a Kerberos V4 identity, both, or only the unauthenticated AIX identity. The server then tries to establish an authenticated identity for the client. Depending on which authentication methods are enabled and the availability of valid credentials, the server first tries a DCE principal, then a Kerberos V4 principal, and finally the AIX user name. When authentication succeeds using DCE, the server does not use other credentials submitted by the client. Authentication of the client by the server might fail because the credentials are invalid, the credentials are expired, or the server host is not configured to support any of the authentication methods enabled for the SP trusted services.

Note: Messages reporting authentication errors are always suppressed if the client request is eventually successfully authorized because authorization did not require any of the unavailable forms of identity. When authorization does fail, it means that none of the identities established for the client are allowed to perform the requested task: neither DCE principal, Kerberos V4 principal, nor unauthenticated AIX user name. Following an authorization failure, all authentication failures are reported to the user, if any had occurred.

However do not infer, without investigating further, that a reported authentication failure was actually the reason for a denial of access. Denial of access can be caused by things other than authentication failures, such as the following:

- Failure of an administrator to grant access, for example by not adding a principal to a group or not adding an entry to an ACL file.
- Denial by a customized authorization callback procedure.

Using Sysctl with Mixed Authentication Environments

Given the flexibility in configuring security services on the SP system, the possibility that you might install and configure the SP security services client facilities on independent workstations, and the support for coexistence and interoperability of PSSP 3.2 with earlier versions, your SP system can have a complex security environment with multiple hosts configured differently. Though Kerberos V4 is now optional, unless you have a brand new SP system using PSSP 3.2 with only DCE authentication, Kerberos V4 must be configured in order for authentication to succeed. When the compatibility authentication method is in use on the system, but DCE is not, users must have Kerberos V4 credentials to use Sysctl facilities that require an authenticated identity. This is also true when any node is running with a PSSP release earlier than PSSP 3.2.

When all hosts are running PSSP 3.2, you do not have to configure and use any authentication methods for SP trusted services if the security policy of your organization allows access by unauthenticated clients. Where clients are allowed to be unauthenticated anonymous users, users can access Sysctl servers without regard to the security configuration. When used in this fashion, Sysctl provides no protection from unlimited access to root privileges on the server system. Avoid that mode of operation except, for example during initial installation, when all hosts are physically isolated from the network and access to the system is limited to authorized administrators.

Authorization

When a user submits a Sysctl request, the process establishes the identity of the client, then that identity is used to determine whether the client has permission to do what is requested. The client can have any of the following forms of identity for authorization:

1. An authenticated DCE principal.
2. An authenticated Kerberos V4 principal.
3. An unauthenticated AIX user name.[2]

After the identity is established, the server uses the following authorization steps by default:

1. The **svcconnect** callback is executed to apply a global level of access control to all requests.
2. The request is passed to the Tcl interpreter which in turn executes the authorization callbacks for each procedure and variable referenced directly by the client request.

Unless you have reconfigured Sysctl without an **svcconnect** procedure, each request must be authorized by that procedure before proceeding to the second step. The default **svcconnect** policy is to allow requests only from authenticated

[2] Client requests from systems running earlier versions than PSSP 3.2 do not provide the AIX user name, so the client is anonymous.

clients when any authentication method for SP trusted services is used on the server host, and to allow all requests on hosts with no authentication method in use for SP trusted services. See the **svcconnect** Sysctl procedure for information on overriding the default policy.

After a request passes the first authorization step, access rights are determined by how access control is defined for individual Sysctl resources on your SP system. Sysctl supports multiple authorization methods. The most widely used and most flexible is based on access control lists. Each Sysctl procedure and read-only variable is associated at server configuration time with a Tcl procedure called an authorization callback. Basically, it is a procedure that Sysctl invokes immediately before accessing the object it protects, to determine whether to allow that access. It can use the identity of the client and server state information stored in predefined Tcl variables to make its decision. Apart from the predefined callbacks, Sysctl allows the author of a Sysctl procedure to provide a unique callback based on arbitrarily defined factors.

Built-in Authorization Callbacks: IBM provides and uses four predefined authorization callback procedures. You can also use them as they are, change them, or write others. The predefined callback procedures are the following:

NONE A procedure that always returns a successful result. This allows access by any user: authenticated or not.

SYSTEM A procedure that does not allow access by a client. It is used to protect from direct access by the client, a procedure or variable that is used internally by already-defined procedures.

AUTH A procedure that returns a successful result if the client was authenticated, regardless of the method used. This allows access by any user with valid credentials, provided the server is configured to support the authentication method in use for SP trusted services to obtain those credentials.

ACL A procedure that checks whether an access control list authorizes client access.

When the ACL callback is used to authorize a DCE principal, the name of the ACL in the callback specification is the name of a DCE object known to the DCE ACL management functions in the Sysctl server. When Sysctl is configured, each ACL object referenced by authorization callbacks is created by the server, if it did not previously exist. Each object has an owner that has control access (c permission) which grants the right to modify the ACL. The default owner for ACL objects is the **spsec-admin** group. This group is defined when PSSP is configured in the DCE cell, with the DCE cell administrator as its only member. The cell administrator must add other members to the group, as required by local security policy.

Members of the **spsec-admin** group use the DCE **dcecp** command to create, change, remove, and list ACL entries. The **dcecp** command requires references to objects to be fully qualified CDS names, consisting of the cell name (or the string **/.:** to denote the local cell), the CDS directory path for the RPC entry for the server, and the residual object name. For Sysctl, the CDS path to the Sysctl server on DCE host *DCEhostname* is **/.:/subsys/ssp/***DCEhostname***/sysctl**. The object name appended to the CDS path is the name in the ACL callback specification. For the permissions related to Sysctl objects, see "Permissions in Sysctl ACLs" on page 119.

To add an entry for DCE principal **sarah** to the problem management ACL on the node whose DCE hostname is **node8**, for example, an authorized administrator would execute the following **dcecp** subcommand:

```
acl modify /.:/subsys/ssp/node8/sysctl/etc/sysctl.pman.acl \
-entry -add user:sarah:at
```

When an ACL callback is used to authorize a request by a client other than a DCE principal, the name of the ACL is used as the fully qualified path name of an ASCII format file in which you have created ACL entries. If the callback is **{ACL}** with no path name, the default file defined by the **$ACL** variable is used. You create ACL entries in these files using built-in Sysctl procedures or an editor of your choice. Since the authorization callback for the **acladd** command is **{ACL}**, the entry in the default ACL file cannot be added using **acladd**, unless the user is authorized using DCE (such as by being a member of the **sysctl-master** DCE group).

When the server is running with both DCE and compatibility authentication methods active, it is only necessary to be authorized by either DCE or Kerberos V4 authentication. To avoid confusion, you might want to keep the authorization information in the DCE ACLs and groups consistent with information in the Kerberos V4 Sysctl ACL files. For example, to add an entry for Kerberos V4 principal **sarah** to the problem management ACL on all hosts listed in the **/tmp/sphosts** file, you might use the following command:

```
sysctl -c /tmp/sphosts acladd -f /etc/sysctl.pman.acl -p sarah
```

To use the **acladd** command, you would have to be authorized for global Sysctl access by an entry in the **/etc/sysctl.acl** file. Another way is to edit the files directly, but you would have to log in as root on each host to do it.

Using Authorization Callbacks: ACLs provide the most flexibility in implementing your access controls. The ways to authorize a client request differ depending on the form of identity established at the server. Note that a given client can have different identities for the same request on different target servers, since the identity is determined in part by the capabilities of the server.

A client authenticated using DCE can be granted access by the following:

a NONE callback
an AUTH callback
an ACL callback and a DCE ACL entry for the DCE principal
an ACL callback and a DCE ACL entry for a group in the principals project list
an ACL callback and a DCE ACL entry for any authenticated client
a locally provided callback

A client authenticated using Kerberos V4 can be granted access by the following:

a NONE callback
an AUTH callback
an ACL callback and a Sysctl ACL file entry for the Kerberos V4 principal
an ACL callback and a Sysctl ACL file entry for any other authenticated client

a locally provided callback

An unauthenticated client can be granted access by the following:

a NONE callback
an ACL callback and a Sysctl ACL file entry for all unauthenticated clients
a locally provided callback

Bypassing Authorization Callbacks: There is an entry defined in the Sysctl ACL file that allows access to all unauthenticated users. This applies to requests from clients who have no Kerberos V4 or DCE credentials as well as to requests submitted using the command line option to bypass authentication.

In some situations, the server bypasses the authorization callbacks. Authorization callbacks are bypassed while the server does the following:

- Reads configuration files (that is, when starting up).
- Executes an authorization callback.
- Executes the body of a procedure that a user is authorized to run.

Sysctl Executables

Sysctl Daemon (sysctld)

The Sysctl server daemon, **sysctld**, processes all Sysctl client requests for the node on which it runs. There is a **sysctld** daemon running on each node of the SP system, as well as on the control workstation. The **sysctld** daemon runs as root and executes Tcl procedures for authenticated and authorized clients who may be local or remote users. See the **sysctld** man page for more information.

Client (sysctl)

The Sysctl client shell program, **sysctl**, offers a command line interface for communicating with **sysctld**. Together, **sysctl** and **sysctld** provide monitoring and execution abilities needed to remotely manage SP nodes. **sysctl** connects to a remote node's **sysctld** using TCP/IP, passes keywords and commands to the server, and writes any output returned to **stdout** and **stderr**. See the **sysctl** man page for more information.

Sysctl Files

The Sysctl server files include the following:

- Sysctl configuration files
- Access Control List (ACL) files
- Sysctl log file

Using the Default Sysctl Server Configuration File

A configuration file is provided when Sysctl is installed on the control workstation and on each SP node. The default path name for this file is **/etc/sysctl.conf**. The configuration file modifies the state of the server by executing one or more configuration commands. The configuration commands create read-only variables, register procedures, include other configuration files, and create classes of commands.

Customizing the Sysctl Server Configuration File

You can customize Sysctl servers by manipulating this configuration file. Initial configuration takes place each time the **sysctld** daemon is started on an SP node or control workstation. When the PSSP software is installed, a script creates the **sysctld** subsystem under SRC control and adds an entry to the inittab to start it at boot time. When started, the daemon sets up its Tcl interpreter tables to contain the built-in procedures supplied with the product. Then it executes the **/etc/sysctl.conf** file, which is a Tcl script that invokes Sysctl procedures to create additional Sysctl objects (procedures, variables, and classes) that are provided for managing the SP system.

You can tailor the configuration file after initial installation to make your own additions or changes to the base Sysctl facilities. You can insert Sysctl and basic Tcl procedures that create new objects or change existing objects. You might prefer to create a separate customization script and add it to the default configuration file with an include procedure that names the new script. That method is used by the log management component of PSSP to add its Sysctl configuration information to the server.

You can use the **create proc** built-in procedure to add new procedures and the **setauth** built-in procedure to change the authorization callbacks assigned to already configured procedures. Authorization callbacks are bypassed during configuration, allowing any built-in Sysctl procedures to be invoked from within configuration scripts. For security, only root should have write authority to Sysctl configuration files, including any that you create.

When you assign an authorization callback procedure, the server does not check to see whether it exists. The following messages generated using the security auditing option show successful setting of a nonexistent callback:

```
Sep 10 10:30:55 AUDIT[cmd]: Creating procedure xxtest, callBack = {NoAuth}
Sep 10 10:30:55 AUDIT[sec]: Setting callback for command "xxtest" => {NoAuth}
```

When you try to use the procedure or variable protected by a nonexistent callback, however, the error will simply be reported as an authorization failure. If you run with security auditing turned on, messages like the following should be recorded in the server's log file:

```
Sep 10 10:31:17 <37d91620> AUDIT[tcl]: Evaluating: xxtest
Sep 10 10:31:17 <37d91620> AUDIT[sec]: Checking object authorization
                callback for command "xxtest": NoAuth
Sep 10 10:31:17 <37d91620> AUDIT[sec]: interp>result from object
                callback {NoAuth} = "Not a valid command name: "NoAuth"", retCode = 1
Sep 10 10:31:17 <37d91620> AUDIT[sec]: Authorization denied for command "xxtest"
```

See “Sysctl Installation and Configuration Information” on page 122, the **sysctld** man page, and the **sysctl.conf** man page for more information about configuring your system for Sysctl.

ACL Files Provided for Sysctl

The following ACL files that Sysctl uses are provided:

- The default Sysctl ACL **/etc/sysctl.acl** (or an overriding name supplied locally by the administrator).

This identifies *trusted users* for servers. Trusted users are authorized to run any Sysctl or Tcl procedure, except for those with the SYSTEM authorization level. Trusted users have privileges equal to those of a root user.

- ACLs referenced by callbacks from other SP components.
  - **/etc/logmgt.acl** – See Chapter 29, "Managing Error Logs" on page 431
  - **/etc/sysctl.pman.acl** – See Chapter 27, "Using the Problem Management Subsystem" on page 405
  - **/etc/sysctl.rootcmds.acl** – See "Authorizing Users for SP Perspectives" on page 295
  - **/etc/sysctl.vsd.acl** – See the book *PSSP: Managing Shared Disks*.
  - **/etc/sysctl.mmcmd.acl** – See the book *IBM General Parallel File System for AIX (GPFS)*.
- Locally created ACL files

  You can create ACL files to customize existing Sysctl facilities or add new ones. For example, you might designate a set of users that can issue a particular Sysctl procedure by creating an ACL for that procedure. The authorization callback of the procedure can be set to reference your ACL.

DCE ACLs

The ACLs that Sysctl uses to authorize requests by authenticated DCE principals are not individual files that you manage directly, but data maintained by DCE and the Sysctl server in a database. There is an SP ACL management component of PSSP. You can manipulate the entries in the ACLs by using the SP ACL management or by using the standard DCE ACL management tools such as the **dcecp** command. Your interface to SP ACL management includes the **spacl** command and the **spauth_spacl** SMIT fastpath. See "Managing DCE ACLs for SP Trusted Services" on page 51.

If you use the DCE commands you must refer to the ACL using a fully-qualified CDS path of the server with the ACL name, as specified in the callback, appended to it. See the description of the ACL callback in "Built-in Authorization Callbacks" on page 115 for details. Because DCE ACLs are managed by the server that owns them in cooperation with DCE, **sysctld** must be running in order to issue **dcecp** subcommands that reference Sysctl ACLs.

Permissions in Sysctl ACLs: DCE requires that all ACLs have at least one entry that grants control (c) permission: the authority to manage the ACL. All ACLs used by Sysctl are created with an initial entry that grants control authority to the **spsec-admin** DCE group. The group and initial members are established when the PSSP software is installed and configured. Unless the name has been locally overridden, the DCE **cell_admin** user principal is a member by default. Though you can create additional ACL entries granting control permission, the easiest and preferred method is to add members to the **spsec-admin** DCE group.

All other entries use only three permissions:

a	Grants access to all Sysctl procedures and variables protected by the ACL.
t	Allows a user to issue the **acl check** subcommand of **dcecp**.
-	Used to deny access.

ACLs used by Sysctl with DCE: Sysctl uses the following ACLs when the DCE authentication method is in use:

- **etc/sysctl.acl**

  This ACL is created when Sysctl is started on the system. It initially contains one entry for the **spsec-admin** DCE group already discussed and another with ***a*** and ***t*** permissions for the **sysctl-master** group. No members are predefined for this group. You can add DCE principals of persons who are trusted to use all Sysctl facilities, including the ability to reconfigure Sysctl. If you do not give this level of authority to at least one DCE principal, the procedures that use the default ACL callback for authorization will not be available to anyone unless you redefine the callbacks by customizing the Sysctl configuration.

- ACLs for other SP software components that use Sysctl.

  Like the global ACL, these are also created with an initial entry for the **spsec-admin** DCE group. Other entries are defined by the individual subsystem that uses them. The authorization instructions for each subsystem indicate how you can tailor these ACLs.

- Locally created ACLs.

  You do not create a DCE ACL directly. The Sysctl server creates it automatically, while processing the configuration file, when it first finds a reference to it in an ACL callback. As with the predefined ACLs, it creates an entry for the **spsec-admin** DCE group. Therefore, first you update the configuration file to use an ACL callback that references the new ACL that you want to create. Then restart Sysctl. Then you can update the new ACL file using the **dcecp** command to create all other entries.

  If you write a callback that invokes the **acl check** procedure rather than using the ACL callback with your locally created ACL file, Sysctl will not recognize your ACL definition and will not create the new ACL. If you want to define an ACL of that nature, define a dummy variable with {ACL *your-acl-name*} as its callback. For example, specify in the configuration file:

  ```
  create proc z_callback {} NONE {
  .. if {[aclcheck -f /var/z/acl]} {..} ..
  }
  create proc z_proc {..} z_callback {..}
  create var z_var {} {ACL /var/z/acl}
  ```

  The following example uses the **dcecp** command to add an entry and show the contents of an ACL:

  ```
  dcecp -c acl modify /.:/subsys/ssp/abc/sysctl/etc/logmgt.acl -entry \
  -add user:nogojoe:-
  dcecp -c acl show /.:/subsys/ssp/abc/sysctl/etc/logmgt.acl -entry
  {group:spsec-admin:c}
  {group:sysctl-logmgt:at}
  {user:nogojoe:-}
  ```

Sysctl creates only group entries in its DCE ACLs. See “Types of DCE ACL Entries” on page 52 for other types of DCE ACL entries that are supported.

Kerberos V4 ACLs

The format of these ASCII text files is explained in the **sysctl.acl** section of the book *PSSP: Command and Technical Reference*.

Sysctl uses the following ACLs when the Kerberos V4 authentication method is in use:

- The **/etc/sysctl.acl** file.

  This ACL file is installed with the product and initially contains no entries. You add entries for Kerberos V4 principals of persons you want to authorize according to your organizations security policy. If you do not give this level of authorization to at least one Kerberos V4 principal, the procedures that use the default ACL callback for authorization will not be available to anyone unless you redefine the callbacks by customizing the Sysctl configuration.

  The supplied **/etc/sysctl.acl** file contains commented lines that are samples. Copy the sample lines and insert your own principal identifiers.

- ACLs installed with other SP software components.

  These ACL files might be initially empty or they might contain entries that are generated during installation and configuration of the relevant SP software component or LPP. The authorization instructions for that component indicate how you can tailor these ACLs.

- Locally created ACLs

  When you add entries to existing files or create your own, remember that the types of entries you need depends on which SP trusted service authentication methods the local server host is using.

The following is a sample Sysctl ACL file:

```
#acl#
_principal sarah@TESTCELL.ABC.COM
_principal joe -
_acl_file /etc/mycmd.acl
```

This ACL includes entries for granting access to Kerberos V4 principal **sarah** and denying access to **joe**. The last entry names a file, that contains additional ACL entries.

The root user owns all Sysctl ACL files and is responsible for distributing the file to all nodes that share the same set of Sysctl resources. You can update an ACL file on multiple hosts in parallel using the Sysctl procedures for ACL file management. If you do not use those tools, you might want to use file collections to maintain configuration and ACL files. You can use the authenticated **pcp** command to securely copy files to multiple SP nodes. See Chapter 7, “Managing File Collections” on page 137.

Log File

The **/var/adm/SPlogs/sysctl/sysctld.log** file is a logging file to which the Sysctl daemon (**sysctld**) writes. It logs the invocation of each Sysctl command. This is helpful for debugging. See the **sysctld** man page for information on specifying log file path names.

Sysctl Installation and Configuration Information

Sysctl Installation Information

Sysctl is contained in the installation option file **ssp.sysctl**. This is installed when you install the SP system management software. See the *PSSP: Installation and Migration Guide* for more information.

Sysctl Configuration Information

The basic procedure for configuring the system for Sysctl follows. Most of the steps are performed for you, either by the installation process or when you run **setup_authent** (both processes are described in *PSSP: Installation and Migration Guide*).

Note: Some of these steps require administrative access to the authentication database. See Chapter 2, "Security Features of the SP System" on page 13 for details.

Configuration Steps Done for You

When you install **ssp.sysctl** the following steps happen automatically:

- The **/etc/sysctl.conf** file, which contains configuration information for the **sysctld** daemon, is installed on each node.
- The following, which describes the IP port and protocol used for that port, is added to **/etc/services**:

```
sysctl    6680/tcp   sysctld
```

- **/etc/inittab** is updated to automatically start the **sysctld** daemon. **init**, as root, starts **sysctld** as follows:

```
sysctld:2:once:/usr/bin/startsrc -s sysctld
```

Configuration Steps You Need to Perform

Here are the configuration steps that you need to perform:

- Add any trusted users to the global Sysctl ACL (**/etc/sysctl.acl**).

  When the server is operational, you can manipulate Sysctl ACLs through the Sysctl built-in commands described in Table 7 on page 135.
- Define in the **/etc/sysctl.conf** file any new commands you have created and distribute it to each node either manually or via file collections.
- Optionally, create any new ACLs and distribute them either manually or via file collections to each node.
- If you have modified the configuration file, the **sysctld** daemons must be restarted. See "Developing a Sysctl Application" on page 130 for more information.

Debugging Configuration Problems

For you to be at this point, your Sysctl server has been configured. After obtaining credentials as appropriate for DCE or Kerberos V4, whichever apply, you should be able to perform Sysctl tasks. As a simple test, enter the command:

```
sysctl whoami -v
```

The normal system response is three lines of output showing your DCE identity, your Kerberos V4 identity, and your AIX user ID. If DCE is in use for authentication and you have valid DCE credentials, the first line shows your DCE principal name. If Kerberos V4 is in use for authentication and you have valid Kerberos V4 credentials, the second line shows your Kerberos V4 principal name. The third line shows your AIX user ID. The output looks something like this:

```
DCE: /.../abc.com/andrew

K4: andrew@abc.com

AIX: andrew
```

If you do not have credentials, the system response depends on whether the server uses any authentication methods for SP trusted services. If the server does not use an authentication method, it is not concerned with credentials and the output looks something like this:

```
DCE:

K4:

AIX: andrew
```

If you do not have credentials and the server does use an authentication method, the server returns an error message informing you that you have insufficient authorization. You might have forgotten to issue the **dcecp** or **kinit** command, whichever is appropriate for the authentication method in use. If that is not the case, then either you are not authorized to perform the task or some portion of your Sysctl configuration might be incorrect.

To obtain more information, as the root user, restart the **sysctld** daemon with the debugging and security auditing option turned on. Do that by running the following commands:

```
/usr/bin/stopsrc -s sysctld

/usr/bin/startsrc -s sysctld -a "-sd -l your_debug_log_filepath"
```

The daemon records security and other debugging information in the log file you named.

If you suspect an authentication problem, use the **klist** or the **k4list** command for DCE or Kerberos V4 respectively, to list your current credentials. It lists your principal name and all tickets that are currently in your ticket cache, including the expiration date and time.

If you attempt a Sysctl request from a host in one security domain to a target host in another and have not set up cross-domain authentication capability, you will receive error messages in addition to the authorization failure that might be misleading. For instance, the following message indicates that DCE could not provide the client with a service ticket for the target server. It has nothing to do with whether you have issued the **dce_login** command.

> 2502-603 You do not have DCE credentials.
>
> Server not found in Kerberos database

Similarly, this message indicates that Kerberos V4 could not provide the client with a service ticket for the target server. It has nothing to do with whether you have issued the k4init command.

> 2502-608 Kerberos error in krb_mk_req:
>
> 2504-008 Kerberos principal unknown

Sysctl Configuration Commands

Configuration commands create read-only variables, register procedures, include other configuration files, and create classes of procedures. Configuration commands are interpreted when a server is started or restarted, and are contained in configuration files. The configuration commands are:

- **include**
- **create var**
- **create proc**
- **create class**
- **set**
- **load**
- Any other valid Sysctl command

include

The **include** command specifies additional configuration files for the server to read. This makes it easier to manage many external command definitions by letting them be split among a hierarchical set of files. The following example causes the Sysctl server to read the contents of the specified file at initialization time:

```
include $buildTop/samples/sysctl/pdfpfck.cmds
```

The syntax of **include** is:

```
include filename
```

create var

The **create var** command defines a read-only variable in the Sysctl server. Variables defined in the configuration file using the standard Tcl **set** command exist only while the configuration files are being read.

The syntax of **create var** is:

```
create var variable value [authcallback]
```

where:

variable	A read-only variable to which you assign a value.
value	The value of the variable

authcallback
: An authorization callback for the command. This can be **NONE, AUTH, ACL** or **SYSTEM** (to assign it one of the built-in authorization levels), or the name of another previously-registered procedure.

The following example defines a variable (**STARTTIME**) that contains the time you started up the server:

```
create var STARTTIME [exec /bin/date] NONE
```

create proc

The **create proc** command defines external Sysctl procedures.

The syntax of **create proc** is:

```
create proc name args authcallback body
```

where:

name
: The name of the Sysctl procedure you are creating.

args
: A list of argument names to the procedure.

authcallback
: An authorization specifier for the command. This can be **NONE, AUTH, ACL** or **SYSTEM** (to assign it one of the built-in authorization levels), or the name of a previously-registered procedure.

body
: A Tcl expression that forms the body of the new procedure.

See "Developing a Sysctl Application" on page 130 for an example of **create proc**.

create class

The **create class** command defines classes of commands within the server. Command classes provide a way to organize commands into logical groups for clarity.

The syntax of **create class** is:

```
create class name file [authcallback]
```

where

name
: The name that you assign to the command class.

  This name constitutes a **tag** that is prefixed to all commands defined in the command file.

  For example, if a class named **test** is created and the class file defines a procedure named **help**, the procedure is created in the interpreters as **test:help**.

file
: The path name of the file containing the definition of the class objects.

authcallback
: An authorization specifier for the command. This can be **NONE, AUTH, ACL** or **SYSTEM** (to assign it one of the built-in authorization levels), or the name of a previously-registered procedure.

set

The **set** statement sets the value of the server variables ACL, LOG or KEY, or sets values in the Tcl env() array. The default values for the Sysctl server's ACL file, log file and Kerberos key file can be overridden by assigning values to the ACL, LOG and KEY variables in the configuration file. For example, the following line overrides the default value for the log file name:

```
set LOG /var/sysctld.logfile
```

The values assigned to the ACL, LOG and KEY variables are overridden by the optional command line arguments **-a**, **.-l** and **-k** on the **sysctld** command line. Environment variables (such as the default PATH) can also be set within the configuration file by assigning values to the env() array. For example:

```
set env(PATH) /usr/bin:/bin:/usr/etc:/etc
```

sets the PATH environment variable for the Sysctl server. The env() array is assigned an authorization callback of SYSTEM which prevents its modification from outside the Sysctl server by a request sent by a Sysctl client.

load

The **load** command dynamically loads the shared library at **lib_path** into memory. If the **init_proc** parameter is given, it is used as the library's initialization procedure. Otherwise the name of the initialization function is derived from the library name as follows:

```
        library name    init function
        ============    =============
        libxxx.sl       xxx_Init()
        libxxx.a        xxx_Init()
```

The Sysctl server exports an API that the library uses to define commands, variables, authorization callbacks and interpreter deletion callbacks. See the **load** help page for details.

Other Sysctl Commands

You can include other commands in the Sysctl configuration file. These commands are executed by the server when it is started (or restarted).

Authorization Tasks

Authorization Callbacks

Sysctl provides an extremely flexible authentication mechanism to allow you to restrict the use of registered Sysctl procedures to any easily defined subset of users. Authorization callbacks are the means by which this authentication is implemented. As previously discussed, Sysctl includes four supplied authorization callbacks which provide the following authorization levels:

- NONE
- AUTH
- ACL
- SYSTEM

Adding New Authorization Callbacks

As an administrator you can develop a procedure with an authorization level that does not fit one of the supplied authorization callbacks. To do this, write your own authorization callback. Here is an example of a custom authorization callback:

```
create proc scdate {} SYSTEM {exec /bin/date}


create proc RCRAUTH {cmdName} SYSTEM {
    global SCUSER
    global SCPRINCIPAL
    if {$SCUSER != "rcr"} {
        svclog "Denying \"$cmdName\" access for user $SCPRINCIPAL"
        error "Authorization denied!"
    } else {
        svclog "Authorizing \"$cmdName\" access for user $SCPRINCIPAL"
        return "Authorization OK!"
    }
}

create proc rcrdate {} {RCRAUTH rcrdate} {scdate}
```

This example contains the definition of three procedures:

- **scdate** is a procedure that the SYSTEM authorization callback is attached to. The SYSTEM callback prevents **scdate** from being directly executed from outside of the server (that is, a user cannot successfully issue **scdate** from the Sysctl client). The **scdate** procedure can, however, be successfully executed from within another procedure which has been previously registered with the Server (that is, included in the Sysctl configuration file), since authorization callbacks are bypassed during this execution.
- **RCRAUTH** is a procedure that functions as an authorization callback. It accepts a command name as its single argument (used for logging purposes only). Its function is to return a normal result if the base name of the user is **rcr** and to return an error result in all other cases.
- **rcrdate** is a procedure that invokes the **scdate** procedure. Before control is given to the **scdate** procedure, the RCRAUTH authorization callback is invoked. If the base name of the user is **rcr**, then the callback returns a normal result and the **scdate** command is allowed to be invoked. If the callback returns an error result, then the **rcrdate** procedure is terminated.

ACL Files in Authorization Callbacks

The supplied **ACL** authorization callback is used to check for the remote user's principal name in an ACL file. If this callback is used without any parameters then the ACL file named by the ACL variable (normally **/etc/sysctl.acl**) is checked. If a file name is supplied as a variable to the ACL callback, then that file is checked for the user's principal name.

This allows an authorization callback to reference an alternate ACL file in performing the authorization check:

```
create proc myproc {} {ACL /etc/myproc.acl} {
       ....
       ....
       ....
}
```

The previous example defines the procedure **myproc**, which takes no parameters, and has an authorization callback of **ACL /etc/myproc.acl**. This callback returns a normal result if the remote user's principal name appears in the file **/etc/myproc.acl** and an error return if it does not.

ACL files can be created and deleted and their contents can be manipulated and checked by using the Sysctl commands **aclcreate**, **acldestroy**, **acladd**, **acldelete**, **acllist**, **aclcheck** and **aclrecreate** (see the Sysctl help information for these commands).

Using Sysctl

Prerequisite Checklist

Before using Sysctl, the following are required:

- Configuration of Sysctl is complete and the **sysctld** daemon is running on all target (server) nodes. See “Sysctl Configuration Information” on page 122.
- If the client and any server systems have the DCE authentication method in use, you have logged in to DCE either at AIX login through integrated login or using the **dce_login** command. This is not required if unauthenticated users are allowed to access the Sysctl facilities that you intend to use.
- If the client and any server systems have the compatibility authentication method in use and at least one of them does not use DCE authentication, you have logged in to Kerberos V4 either at AIX login or by using the **k4init** command. This is not required if unauthenticated users are allowed to access the Sysctl facilities that you intend to use.
- ACLs that protect Sysctl objects you intend to use have been updated to contain an entry that grants you access. The kinds of ACL entries you need depend on the forms of identity you will use when making Sysctl requests.

Note: Keep in mind that output of Sysctl requests might contain unnumbered error messages. Sysctl procedures produce messages with and without message numbers. Those that are not numbered are text generated by Tcl code added by local customization or the output of the embedded Tcl interpreter. The internationalization of the public Tcl interpreter code by IBM did not include changing the content of messages to include AIX-style message numbers.

Using Sysctl in Interactive Mode

Sysctl has an interactive mode. Note that only one node can be communicated with at a time in interactive mode.

To enter interactive mode, enter the **sysctl** client command without a command argument. For example, to use Sysctl in interactive mode on the local node, enter:

```
sysctl
```

If you issued the command from **diane.kgn.ibm.com**, you get the following prompt:

```
Sysctl (Version 1.1) on diane.kgn.ibm.com
sysctl>
```

At this point, you can enter Sysctl commands.

You can also specify some of the Sysctl flags when going into interactive mode. For example, to use Sysctl in interactive mode for node **redhook.kgn.ibm.com**, enter:

```
sysctl -h redhook.kgn.ibm.com
```

Sysctl issues this response:

```
Sysctl (Version 1.1) on redhook.kgn.ibm.com
sysctl>
```

In this example, if you enter **svcversion** and **pdf**, the interaction is as follows, where your actions are in **bold**:

```
sysctl> svcversion
```

1.1 sysctl> **pdf**

```
redhook.kgn.ibm.com: =========================================================
Filesystem                Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
/                            8192    5164    3028   37%    815   1233    61%
/var                        16384    4176   12208   75%    343   3753    92%
/usr                       552960  467888   85072   16%  23203 116061    84%
/tmp                        49152   23860   25292   52%    235  12053    99%
/home                       65536   63556    1980    4%   5375  11009    68%
sysctl> quit
```

To exit the interactive mode, enter one of the following:

```
   exit
   quit
   <Ctrl-d>
```

Using Sysctl in Noninteractive Mode

Sending Commands to a Local Server

If no target nodes are specified on the Sysctl command, the command is sent to the server on the local node. For example, to send the **whoami** command to the local server, enter:

```
sysctl whoami
```

Directing Commands to Remote Hosts

To direct a command to remote host **sivle**, use **-h** and enter:

```
sysctl -h sivle sys:info
```

The system response is similar to:

```
sivle.kgn.ibm.com power AIX 4.3.2
```

To direct a command to remote hosts **sivle**, and **yelserp**, enter:

```
sysctl -h sivle -h yelserp sys:info
```

The system response is similar to:

```
>> sivle
sivle.kgn.ibm.com power AIX 4.3.2
<<
>> yelserp
yelserp.kgn.ibm.com power AIX 4.3.2
<<
```

Sending Commands to a Collection of Nodes

Multiple nodes can be targeted with a single Sysctl command. The collection of nodes can be specified in a file. Alternatively, the Sysctl command will read node names from **stdin**. In the following example, the file **/tmp/node-file** contains node names **r05n13.hpssl.kgn.ibm.com**, **r05n15.hpssl.kgn.ibm.com**, and **r05n09.hpssl.kgn.ibm.com**.

To direct the **pdf** command to the **/tmp/node-file** collection, enter:

```
sysctl -c /tmp/node-file pdf
```

The response in this example is the following:

```
>> r05n13
r05n13.hpssl.kgn.ibm--------------------------------------------------------
Filesystem                Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
/                            4096    3372     724   18%    792    232    23%
/var                         8192    6320    1872   23%    297   1751    86%
/usr                       335872  331632    4240    2%  17820  66148    79%
/tmp                         8192     520    7672   94%     67   1981    97%
/home                        4096     168    3928   96%     18   1006    99%
<<
>> r05n15
r05n15.hpssl.kgn.ibm--------------------------------------------------------
Filesystem                Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
/                            4096    3364     732   18%    796    228    23%
/var                         8192    3028    5164   64%    281   1767    87%
/usr                       335872  331412    4460    2%  17825  66143    79%
/tmp                         8192     464    7728   95%     57   1991    98%
/home                        4096     168    3928   96%     18   1006    99%
<<
>> r05n09
r05n09.hpssl.kgn.ibm--------------------------------------------------------
Filesystem                Size-KB Used-KB Free-KB %Free  iUsed  iFree %iFree
/                            4096    3340     756   19%    790    234    23%
/var                         8192    3336    4856   60%    285   1763    87%
/usr                       331776  331012     764    1%  17742  66226    79%
/tmp                         8192    1212    6980   86%     58   1990    98%
/home                        4096     164    3932   96%     17   1007    99%
<<
```

Developing a Sysctl Application

Creating a Sysctl application consists of the following basic steps:

| 1. Examine what you are trying to do and divide it among client-server lines. The
| server side runs as root. The client side typically does not require root authority,

but might require that the user has logged in as appropriate for the authentication method that is in use.

2. Define the client-server interface. This consists of Sysctl command names and their arguments, return values, and authorizations.
3. Code the server commands. This consists of Tcl code that performs your task, as well as callback authorizations if you do not use one of the supplied ones. The Tcl code may be simple (such as a wrapper around an AIX command or script) or elaborate (a detailed Tcl program).

   Note: The **stdout** and **stderr** output of scripts called from a Tcl procedure might not automatically be routed back to the client user's terminal. For an example of how to ensure that **stdout** and **stderr** are returned to the client, see how `/etc/root_script` is used in the procedure adminscript on page 131.
4. Code the client side. This typically gathers any necessary information and then issues the **sysctl** command to cause the servers to perform the desired action. This can be a GUI, Perl or shell script. Note that client side code may not always be necessary. In some cases, issuing the **sysctl** command directly from the command line is sufficient.
5. If the authorization scheme requires changes to existing ACL files or new ACL files, these changes must be made, and the changed files distributed.
6. Register the new server command with each node's **sysctld** daemon by restarting the daemons with updated configuration files.

Here is an example of how to write a Sysctl application that allows a user to execute a script including some commands requiring root execution privileges on all the nodes in an SP system in parallel. The user is not required to know any of the root passwords, but must be listed in an ACL specifically set up to authorize use of the script. A copy of this ACL resides on each node. The script containing the commands executable only by root is called **/etc/root_script**. Assume that **/etc/root_script** accepts a single argument, and that this script resides on each node.

The server side of the application does the root part of the job, which is to issue the **/etc/root_script** command with the correct arguments on behalf of authorized users. It first needs to determine if the client is authorized based on an authorization policy. As mentioned above, authorization is based on an access control list. There are no return values, but an error message is displayed when the user is not authorized to run the command. **stdout** and **stderr** are returned to the client.

The server command resides in **/etc/sysctl/apps/adminscript** and is coded as follows:

```
create proc adminscript {argument} AUTH {
        global SCPRINCIPAL
        if [aclcheck -f /etc/sysctl.adminscript.acl $SCPRINCIPAL] {
                puts "[exec /etc/root_script $argument]"
                return
        }
        puts "Not authorized to run adminscript"
}
```

The first line creates a new Sysctl proc called **adminscript**. One argument is accepted, which will be passed unchanged to **/etc/root_script**. This proc uses the provided AUTH authorization callback, which means that only authenticated clients can execute the command.

The second line issues the Tcl **global** command to provide the content of the SCPRINCIPAL variable to other Sysctl commands. (This is needed because SCPRINCIPAL is passed as an argument to **aclcheck** later.) The SCPRINCIPAL variable is the authenticated identity of the command issuer and is one of the variables set by the server and available to procedures and callbacks. See the Sysctld daemon information in the book *PSSP: Command and Technical Reference* for a list of all the variables.

The third line is Tcl code that uses the built-in **aclcheck** command to see if the user is in the ACL (**/etc/sysctl.adminscript.acl**) set up for this command. If the user is authorized, the program issues the **/etc/root_script** command with the supplied argument and then returns. If the user is not authorized, the program issues an error message. The program returns any output (information from **/etc/root_script** command or the error message) to the client user's terminal.

Note that in this example, further authorization checking is done in the body of the procedure after the authorization callback has completed. This is to demonstrate the use of the SCUSER variable provided by the server to procedures. Alternatively, this check could have been made part of the authorization callback itself.

The client side of the application needs to find out the necessary information to provide to the servers. It does not require root authority to be issued. The information in this case includes the single argument to be passed through to **/etc/root_script**. The client also needs to determine the hostnames of all the nodes in the SP System, so that the command can be sent to and run in parallel on all the nodes.

The client side is coded as follows in **/usr/bin/doadminscript**:

```
#!/usr/lpp/ssp/perl/bin/perl

# Run /etc/root_script on all the SP nodes in parallel by invoking
# the adminscript sysctl command on all the nodes. Invoke via:
# doadminscript arg_to_root_script

$#ARGV > 1 && die "too many arguments";

exec "/usr/lpp/ssp/bin/hostlist -av |
      /usr/bin/sysctl -c - adminscript $ARGV[0]";
```

The first line checks for extraneous arguments. The **exec** statement uses the SP **hostlist** command to write all the currently responding hostnames in the SP System to **stdout**. The single argument to **adminscript** is passed along to the Sysctl **adminscript** server command.

A new ACL file needs to be put on each node in the system. The file **/etc/sysctl.adminscript.acl** looks like this:

```
#acl#
# These are the users that can issue the adminscript command on this
# node:
_principal root@HPSSL.KGN.IBM.COM
_principal newbie@HPSSL.KGN.IBM.COM
_principal guru@HPSSL.KGN.IBM.COM
```

Note that each node can authorize different users to run the new command. In this case, assume that the ACL will be the same on all nodes. To distribute the ACL file to all the responding nodes, an authorized user enters the following (see the **pcp** man page for details):

```
pcp "-av" /etc/sysctl.adminscript.acl
```

In addition, the **/etc/sysctl.conf** file needs to be updated to include the new command. If the server code is to reside in **/etc/sysctl/apps** directory, the following lines can be added to **/etc/sysctl.conf**:

```
# Add the adminscript application
include /etc/sysctl/apps/adminscript
```

The updated **sysctl.conf** file and the actual server code need to be distributed:

```
pcp "-av" /etc/sysctl.conf
pcp "-av" /etc/sysctl/apps/adminscript
```

Now the servers need to be restarted to include the updated **sysctl.conf** file. Note that the following command requires ACL authorization:

```
hostlist -av | sysctl -c - svcrestart
```

Now, any of the users in **/etc/sysctl.adminscript.acl** (root, newbie, or guru) can run **/etc/root_script** with the argument **mikef** on all the nodes simultaneously by entering the following command:

```
doadminscript mikef
```

Authorization Variables

Variables are set by the server based on information on the client provided by SP security services. Authorization callbacks and Tcl scripts have access to these variables. See "Sysctld (daemon)" in the book *PSSP: Command and Technical Reference* for a list of all the authorization variables.

Sysctl Reference Information

Reference information for Sysctl includes the following:

- An Online Help Facility
- Tcl Commands
- Extended Tcl Commands
- Built-in Sysctl Commands

Online Help Facility

To access online help on built-in Sysctl commands, enter:

```
sysctl help command-name
```

For example, to access help on the **setauth** command, enter:

```
sysctl help setauth
```

Tcl Commands

Table 5 shows the commands available in the Tcl language interpreter and the Sysctl base authorizations required to use them.

Table 5. Built-in Tcl Commands and Their Default Authorization Callbacks

append (AUTH)	array (AUTH)	break (AUTH)	case (AUTH)
catch (AUTH)	cd (ACL)	close (ACL)	concat (AUTH)
continue (AUTH)	eof (ACL)	error (AUTH)	eval (ACL)
exec (ACL)	exit (AUTH)	expr (AUTH)	file (ACL)
flush (ACL)	for (ACL)	foreach (ACL)	format (AUTH)
gets (ACL)	glob (ACL)	global (AUTH)	history (AUTH)
if (AUTH)	incr (AUTH)	info (ACL)	join (AUTH)
lappend (AUTH)	lindex (AUTH)	linsert (AUTH)	list (AUTH)
llength (AUTH)	lrange (AUTH)	lreplace (AUTH)	lsearch (AUTH)
lsort (AUTH)	open (ACL)	pid (ACL)	proc (SYSTEM)
puts (ACL)	pwd (ACL)	read (ACL)	regexp (AUTH)
regsub (AUTH)	rename (SYSTEM)	return (NONE)	scan (AUTH)
seek (ACL)	set (AUTH)	source (SYSTEM)	split (AUTH)
string (AUTH)	switch (AUTH)	tell (ACL)	time (ACL)
trace (ACL)	unset (AUTH)	uplevel (SYSTEM)	upvar (ACL)
while (ACL)			

Extended Tcl Commands

Table 6 shows the commands available in the TclX language interpreter and the Sysctl base authorizations required to use them.

Table 6. Built-in Extended Tcl Commands and Their Default Authorization Callbacks

alarm (ACL)	bsearch (ACL)	catclose (ACL)	catgets (ACL)
catopen (ACL)	cequal (AUTH)	cexpand (AUTH)	chgrp (ACL)
chmod (ACL)	chown (ACL)	chroot (SYSTEM)	cindex (AUTH)
clength (AUTH)	cmdtrace (ACL)	commandloop (ACL)	convertclock (AUTH)
copyfile (ACL)	crange (AUTH)	csubstr (AUTH)	ctoken (AUTH)
ctype (AUTH)	dup (ACL)	echo (AUTH)	execl (ACL)
fcntl (ACL)	flock (ACL)	fmtclock (AUTH)	fork (ACL)
frename (ACL)	fstat (ACL)	funlock (ACL)	getclock (AUTH)
id (ACL)	infox (ACL)	keyldel (AUTH)	keylget (AUTH)
keylkeys (AUTH)	keylset (AUTH)	kill (ACL)	lassign (AUTH)
lempty (ACL)	lgets (ACL)	link (ACL)	lmatch (AUTH)
loop (ACL)	lvarcat (AUTH)	lvarpop (AUTH)	lvarpush (AUTH)
max (ACL)	min (ACL)	mkdir (ACL)	nice (ACL)
pipe (ACL)	profile (ACL)	random (AUTH)	readdir (ACL)
replicate (AUTH)	rmdir (ACL)	scancontext (ACL)	scanfile (ACL)
scanmatch (ACL)	select (ACL)	server_open (ACL)	signal (ACL)
sleep (ACL)	sync (ACL)	system (ACL)	times (ACL)
translit (AUTH)	umask (ACL)	unlink (ACL)	wait (ACL)

Built-in Sysctl Commands

The following Sysctl commands are provided:

Table 7. ACL Processing Commands

ACL Processing Commands	Default Auth	Description
acladd	ACL	Adds entries to an ACL file. If a filename is not specified, the entry is added to the server's ACL file.
aclcheck	ACL	Checks to see if a principal is in an ACL file. Returns **1** if in ACL, **0** if not in ACL. If no filename is specified, Sysctl looks in the server's ACL file.
aclcreate	ACL	Creates a new ACL file, inserting the principals specified. The **-f** parameter must be supplied.
acldelete	ACL	Deletes an ACL from a file.
acldestroy	ACL	Erases an ACL file.
acllist	NONE	Lists the ACLs in a file. If no file is specified, the server's ACL file is listed.
aclrecreate	ACL	Similar to **aclcreate**, but removes the target ACL file if it already exists before creating it again.

Table 8. Service Commands

Service Commands	Default Auth	Description
svcconnect	AUTH	Determines the connection authorization policy for the **sysctld** server.
svcdetach	ACL	Detaches the current process from the calling client; that is, breaks the connection between server and client. Use to start a background daemon.
svclog *string*	ACL	Writes the *string* to the server log file.
svclogevent	SYSTEM	Writes a line to the server log file indicating a user has connected to the server.
svcpid	NONE	Prints the process ID of the **sysctld** server daemon.
svcredirect *handle*	ACL	Redirects the **stdout** and **stderr** for the current session to a new file.
svcrestart	ACL	Restarts the server, causing configuration files to be reread and interpreters to be reinitialized. Use to activate changes to Sysctl servers.
svcversion	NONE	Returns the Sysctl version number.

Table 9. Other Commands		
Other Commands	**Default Auth**	**Description**
ACL	NONE	A supplied authorization callback.
AUTH	NONE	A supplied authorization callback.
NONE	NONE	A supplied authorization callback.
SYSTEM	NONE	A supplied authorization callback.
checkauth	NONE	Determines if you are authorized to access an object.
confadd	ACL	Adds items to a server's configuration file.
confdelete	ACL	Removes items from a server's configuration file.
create	SYSTEM	Creates new objects in the server.
getauth	NONE	Displays the authorization callbacks for an object.
include	SYSTEM	Includes additional configuration files.
listfs	ACL	Lists file system names.
load	SYSTEM	Dynamically load a shared library into the server and call an initialization routine within the library.
quit	NONE	Ends the current session.
safeargs *arg-list*	ACL	Checks arguments for illegal shell characters. Does not execute the command.
safeexec *commands ...*	ACL	Runs the Tcl exec or **system** command, checking arguments for illegal shell characters and preventing execution if any are found.
safesystem	ACL	Runs the Tcl exec or **system** command, checking arguments for illegal shell characters and preventing execution if any are found.
setauth	SYSTEM	Sets the authorization callback for an object.
statfs	ACL	Queries the status of all local file systems.
unload	SYSTEM	Unloads a previously loaded shared library.
whatacls	NONE	Lists ACL objects when using DCE authentication.
whoami	NONE	Echoes the authenticated identity of the issuer or **unknown** if the user is not authenticated.

Chapter 7. Managing File Collections

The SP system installs file collection technology by default to simplify the task of maintaining duplicate files on multiple machines. In the delivered system, the files that are required on the control workstation, boot/install servers, and processor nodes belong to file collections. The master copy of each collection is on the control workstation. A process checks periodically, perhaps once each hour, if any file has been updated. Each file that was updated since the last time it checked, is propagated to the nodes that also have a copy.

This chapter explains the file collections that are delivered with the system. It shows you how to report on, update, and maintain the system file collections, as well as how to build file collections for your own purposes. It explains the basic concepts you need to understand before working with file collections, such as what file collections are, how they differ from standard directories and files, and how they are used in the SP system.

You can easily maintain the integrity of your files also by grouping them into file collections and using the tools provided to manage them. You can manage updates to your files with consistency and accuracy across the multiple nodes in your SP system. With a master version on the control workstation, you can be assured that any modifications are propagated to the nodes within the set time interval.

| **Usage note:**

| To run the commands specified in this chapter, you must be logged in as the
| root user with write access to the SDR.

You might want to take advantage of file collections to maintain files such as **/etc/environment** and **/.kshrc**. You need to read the entire chapter for complete information but briefly, the steps for a typical scenario might be as follows:

1. Develop a list of files you want to update only on the control workstation and have distributed to the nodes of your SP system.
2. Add that list to the **list** file in the file collection **/var/sysman/sup/user.admin**, one line for each file you want distributed, using the syntax:

   ```
   upgrade <full path name of the file>
   ```

   For example,

   ```
   upgrade ./etc/environment
   ```
3. Within the set interval, all the files in the **list** file will be distributed to the nodes. If you do not want to wait, you can force an immediate update by using the command:

   ```
   dsh -a supper update user.admin
   ```

   If your PATH environment variable through dsh is not set to access the **supper** command, you might need to use:

   ```
   dsh -a /var/sysman/supper update user.admin
   ```

There might be cases when you want to distribute some files on the nodes but keep a different version on the control workstation for things you want to start on the nodes but not on the control workstation, for example file **/etc/rc.tcpip**. Use file collection **node.root** in that case, as in this example:

1. To the **list** file in the file collection **/var/sysman/sup/node.root**, add the following:

   ```
   upgrade .
   ```

2. Put the files you want distributed in subdirectories of **/share/power/system/3.2** on the control workstation. For example **/share/power/system/3.2/etc/rc.tcpip** will be distributed to the nodes as **/etc/rc.tcpip**. After this, any file added to the **/share/power/system/3.2** directory is automatically distributed to the nodes.

3. To force immediate update, use the command:

   ```
   dsh -a supper update node.root
   ```

The file collection technology provides you with the means to perform both beginning basic tasks and optional advanced tasks. For the basic tasks, you need only understand the fundamental concepts and be familiar with the delivered file collections. The more advanced tasks require an understanding of the master files, what they contain, and how they work.

Information is presented on the following basic file collection tasks:

- Understanding file collections
- Reporting file collection information
- Verifying file collections using **scan**
- Updating files in a file collection
- Granting permission to obtain a file collection
- Adding and deleting files in a file collection

Information is presented on the following advanced file collection tasks:

- Building a file collection
- Installing a file collection
- Refusing files in a file collection
- Modifying the file collection hierarchy
- Removing a file collection

Understanding File Collections

A *file collection* is a set of files and directories that are duplicated on multiple machines in a network and managed by tools that simplify their control and maintenance. Included with the administrative software is a program called **supper**. The **supper** perl program (**/var/sysman/supper**) uses the Software Update Protocol (SUP) to manage the SP file collections and transfer them across the system.

The following terms are used when defining file collections:

Resident	A file collection that is installed in its true location and able to be served to other systems
Available	A file collection that is not installed in its true location but able to be served to other systems

File collections have unique features:

- A file collection directory does not contain the actual files in the collection. Instead, it contains a set of master files to define the collection. Some master files contain rules to define which files can belong in the collection and others contain control mechanisms, such as time stamps and update locks. These files are explained in "Directory and Master Files" on page 142.
- You handle files in a collection with special procedures and **supper** commands rather than with the standard AIX file commands. The **supper** commands interpret the master files and use the information to install or update the actual files in a collection. You can issue these commands in either batch or interactive mode. The procedures and use of the **supper** commands are detailed throughout this chapter. You can find the command syntax and descriptions in the book *PSSP: Command and Technical Reference*.
- File collections can be either *primary* or *secondary*. Primary file collections can contain other secondary file collections. When a primary collection that contains secondary collections is installed, the secondary collections are *available* but not *resident*. This means they can be served from this location but not actually executed or used there. "File Collection Types" provides further explanation of these concepts.
- File collections require special entries in the file **/var/sysman/file.collections** to define them to the **supper** program. They also require a symbolic link in the **/var/sysman/sup/lists** file pointing to their **list** master file. See "Building a File Collection" on page 154 for an explanation of these entries.
- File collections also require a unique unused user ID for supfilesrv, the file collection daemon, which consists of the user name **supman** and its associated default user ID of 102, along with a unique, unused port through which it can communicate. The default installation configures the user ID attribute *supman_uid* to 102 and the port attribute *supfilesrv_port* to 8431. You can change these values using SMIT or the **spsitenv** command.
- The file collection daemon requires read access permission to any files that you want managed by file collections. For example, if you do not use the SP User Management component of PSSP and you want to distribute files that are under the **/etc/security** directory, you must add **supman** to the security group file **/etc/groups**. This gives read access to the supfilesrv daemon for files that have security group permission, enabling them to be managed across the SP by file collections.

File Collection Types

File collections can be either primary or secondary. A primary file collection can be a stand-alone collection or it can contain a secondary collection. Having a secondary collection allows you to keep a group of files available on a particular machine to serve to other systems without having those files installed.

For example, if you want to have one **.profile** on all nodes and another **.profile** on the control workstation, consider using the **power_system** collection delivered with the IBM Parallel System Support Programs for AIX. This is a primary collection that contains **node.root** as a secondary collection.

- Copy **.profile** to the **/share/power/system/3.2** directory on the control workstation.
- If you issue **supper install power_system** on the boot/install server, the **power_system** collection is installed in the **/share/power/system/3.2** directory.

Because the **node.root** files are in that directory, they cannot be executed on that machine but are available to be served from there. In this case, **.profile** is installed as **/share/power/system/3.2/.profile**.

- If you issue **supper install node.root** on a processor node, the files in **node.root** collection are installed in the **root** directory and, therefore, can be executed. Here, **/share/power/system/3.2/.profile** is installed from the file collection as **/.profile** on the node.

Predefined File Collections

Looking at the file collections delivered with the SP system can help you to understand file collection concepts. You should become familiar with the delivered file collections before you begin to update or add to them.

The SP system provides four predefined file collections:

- **sup.admin**
- **user.admin**
- **power_system**
- **node.root**

You can display information about each collection on a particular machine using the **supper status** command. This reports whether or not the file collection is resident on that machine. To do this, log in as **root** or issue the command remotely. Enter:

```
/var/sysman/supper status
```

You can see a list of the files in a file collection by looking at the **scan** file. See "Verifying File Collections Using scan" on page 147 for instructions on how to do this. The **scan** file contains an entry for each file in the collection that could be installed on a boot/install server or processor node. Certain files in the collection might not exist on one particular system depending on the contents of the **refuse** file on that system. You can find more information about the **scan** and **refuse** files in "Directory and Master Files" on page 142.

SP File Collection Summary

The following table summarizes where these file collections are *resident* or *available* in the SP default configuration.

Control Workstation		Boot/Install Servers		Processor Nodes	
Resident	**Available**	**Resident**	**Available**	**Resident**	**Available**
	sup.admin user.admin power_system node.root	sup.admin user.admin node.root	sup.admin user.admin power_system node.root	sup.admin user.admin node.root	

sup.admin Collection

The **sup.admin** file collection is a primary collection that is *available* from the control workstation, is *resident* (that is, installed) and *available* on the boot/install servers, and *resident* on each processor node.

This file collection is important because it contains the files that define the other file collections. It also contains the file collection programs used to load and manage the collections. Of particular interest in this collection are:

- **/var/sysman/sup** which contains the directories and master files that define all the file collections in the system
- **/var/sysman/supper** which is the Perl code for the **supper** tool
- **/var/sysman/file.collections** which contains entries for each file collection.

user.admin Collection

The **user.admin** file collection is a primary collection that is *available* from the control workstation, *resident* and *available* on the boot/install servers and *resident* on each processor node. This file collection contains files used for user management:

- **/etc/passwd**
- **/etc/group**
- **/etc/security/passwd**
- **/etc/security/group**

The collection also includes the password index files which are used for login performance:

- **/etc/passwd.nm.idx**
- **/etc/passwd.id.idx**
- **/etc/security/passwd.idx**

| **Note:** These files will not be updated if the site environment value for the user
| administration interface is set to `false`.

power_system Collection

The **power_system** file collection is used for files that are system dependent. It is a primary collection that contains one secondary collection called the **node.root** collection. The **power_system** collection contains no files other than those in the **node.root** collection.

The **power_system** collection is *available* from the control workstation and *available* from the boot/install servers. When the **power_system** collection is installed on a boot/install server, the **node.root** file collection is *resident* in the **/share/power/system/3.2** directory and can be served from there.

node.root Collection

This is a secondary file collection under the **power_system** primary collection. The **node.root** collection is *available* from the control workstation, *resident* and *available* on the boot/install servers and *resident* on the processor nodes. It contains key files that are node-specific.

The **node.root** file collection is *available* on the control workstation and the boot/install servers under the **power_system** collection so that it can be served to all the nodes. We do not install **node.root** on the control workstation because the files in this collection might conflict with the control workstation's own **root** files.

Primary and secondary files are defined in the **file.collections** file (see "Step 5: Update the file.collections File" on page 156).

File Collections Organization

When you complete the SP installation and configuration process, the delivered file collections are organized in a hierarchy with the control workstation as the master server for all the collections.

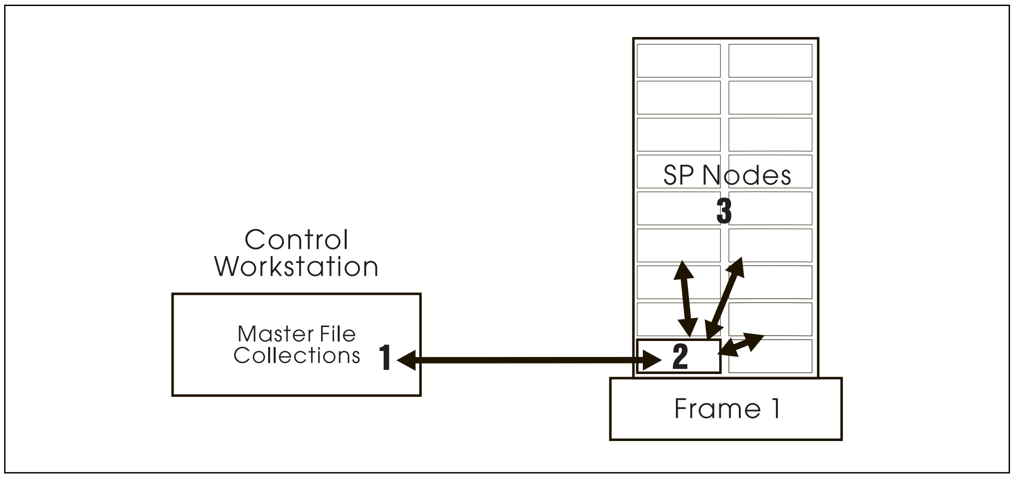


Figure 3. SP Default File Collection Hierarchy

The commands to update the file collections are set up in a **crontabs** file to run hourly in a staggered sequence. Figure 3 shows this organization. Files are updated on the control workstation in the master file collections (**1**). The boot/install servers use **supper update** to request the changes from the control workstation (**2**) and the nodes use **supper.update** to request the changes from the boot/install servers (**3**).

Understanding the File Collection Structure

Before you work with the delivered file collections or build a file collection of your own, you need to understand the directories, master files, what they contain, and how they work.

Directory and Master Files

The **/var/sysman/sup** directory contains master files for all the file collections. Figure 4 shows the structure for this directory.

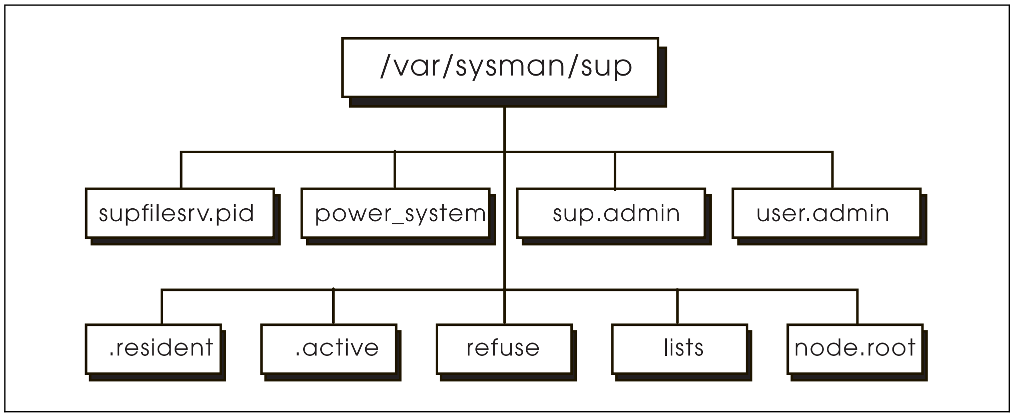


Figure 4. /var/sysman/sup Files and Directories

Following is an explanation of the files and directories.

.active	A file identifying the active volume group. You can modify this file with the **supper activate** command. (This file is not on the control workstation.) This file is present on the nodes depending upon the actions of the administrator.
.resident	Lists each file collection in the SP system. This file needs to be updated when you are adding a new file collection. (This file is not on the control workstation.)
lists	A directory that contains links to the **list** files in each file collection.
node.root	Directory of the master files in the **node.root** collection.
power_system	Directory of the master files in the **power_system** collection.
refuse	On a client system, this is a user-defined (you must define the file; it is not supplied) text file containing a list of files to exclude from all the file collections. This allows you to customize the file collections on each system. You list the files to exclude by their fully qualified names, one per line. You can include directories, but you must also list each file in that directory you want excluded. This file is present on the nodes depending upon the actions of the administrator.
sup.admin	Directory of the master files in the **sup.admin** collection.
supfilesrv.pid	The process ID of the SUP **supfilesrv** process.
user.admin	Directory of the master files in the **user.admin** collection.

Each individual file collection is composed of a directory and several master files. Figure 5 shows the structure for the **sup.admin** file collection in the **/var/sysman/sup/sup.admin** directory. It includes a sample of the file contents. This example shows eight master files. Other file collections might have fewer master files.

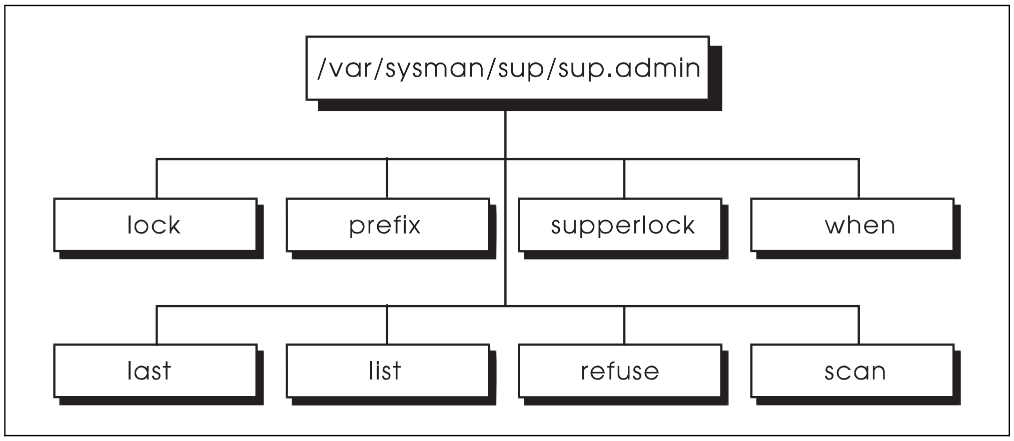


Figure 5. sup.admin Master Files

Following is an explanation of the master files shown in Figure 5.

last	A system-maintained list of files and directories that have been updated. This helps identify files to be deleted on a local machine when they are no longer part of the collection.

The **supper files** command reads the **last** file to obtain a current list of files in the collection. This file is present on the nodes depending upon the actions of the administrator.

list A user-defined file containing special commands. These commands are interpreted by the **supper** scan process to define which files belong to the file collection relative to the base directory specified in the **prefix** file. You can find the specific format for these commands in "supper list File Syntax, Keywords, and Operands" on page 162.

lock An empty file used by SUP to lock a collection and prevent more than one update of the same collection at the same time.

prefix A file containing the name of a directory to be used as the base directory for file references and the starting point for the **supper** scan process. This file is created by the system from data in the **file.collections** file. Keep in mind that the file collection subsystem is designed to allow you to have file collections on SP hosts and on other hosts that might be network connected to the SP system. The **file.collections** file is where you specify characteristics, including the type of system, and the starting directory. That starting directory is put in the **prefix** file, however for any file collection on an SP host, it must always be the root (/) directory.

refuse A system-created file that contains a list of all the files excluded during the update process. If there are no files for this collection listed in the **refuse** file in the **/var/sysman/sup** directory, the **refuse** file in this directory will have no entries.

scan A system-created file containing a list of files that comprise the collection and their permissions and time stamps. This file is the result of the **supper** scan process. It is optional but suggested for all collections and can cause maintenance problems if you do not keep it current.

supperlock Similar to **lock**, an empty file used by **supper** to lock a collection during updates.

when A system-maintained file containing the time of the last file collection update. This file protects against accidental update of a collection with an old version of the files. You can reset it using the **supper reset** command if you need to override this restriction. This file is present on the nodes depending upon the actions of the administrator.

How the Master Files Work

The **supper** master files play a key role during the install, update, and scan processes.

When you run the **supper scan** command for a file collection, the search begins at the point in the directory specified in the **prefix** file and traverses the directory tree to find all the files that meet the criteria defined in the **list** file. The output of this process is the **scan** file which lists the files in the collection. The **scan** file is optional but it documents the file collection contents and eliminates the need for the install and update processes to do the directory search.

The **supper install** and **update** commands use the **scan** file, if it is present, to identify the files to install or update. If a **scan** file is not present, **supper** performs the same directory search to identify the files as it performs when it creates the **scan** file. These commands also check the **refuse** file in **/var/sysman/sup** at each location and bypass any files it contains. As a result, these commands create a **refuse** file in the file collection's directory, listing the files that were bypassed.

During updates, the **lock** and **supperlock** files prevent update access by other SUP or **supper** commands. **supper** checks the update time in the **when** file against the actual file time stamps to verify that you are not updating with an old version of the files and, if so, does not update. It uses the **last** file for additional verification when deleting files that no longer exist in the file collection.

Master File Processing Order: Whether invoked with the **scan, update,** or **install** commands, **supper** performs the search process in the following manner:

prefix Reads this file first to obtain a directory from which it will start the search. For any file collection on an SP host, this is the root (/) directory.

list Reads this file next and processes its commands in the following order:

omit	Marks these files for omission
upgrade	Marks these files for upgrade when updating or installing
always	Overrides any files marked for omission

refuse Reads this file last when it is present on a client (boot/install server or processor node) and does not upgrade any of the specified files on that client.

Automatic Updates: The **supper update** commands are included in the **crontabs** file with the default set to run an update on each of the file collections hourly. You can modify the **crontabs** file to run the **supper update** more or less frequently. Refer to "Updating crontabs on the SP Nodes" on page 217 for more information.

Basic File Collection Tasks

In order to maintain the delivered file collections you will need to perform some basic tasks such as reporting on file collection information, updating files that belong to an existing file collection, and possibly adding or deleting files within an existing file collection. For example:

- To become familiar with the delivered collections you might list their name, access point, and whether or not they are resident. You might also want to verify the complete list of all the files in a collection.
- You might update files such as **/etc/profile** to change the user default profile.
- You might add files such as **/etc/environment** and have them managed by the file collection processes.

You can find basic file collection tasks on pages 138 through 152.

Advanced File Collection Tasks

Once you are familiar with file collection technology, you might want to build your own collections to manage other files on your system that you would like duplicated on multiple machines. You might have a group of files such as application data that you want installed on each node or local tools you want installed on each boot/install server.

The task of building and distributing your own collections is more advanced. It includes creating the directory and master files, adding entries to the **file.collections** and **lists** files, and possibly creating **scan** and **refuse** files. Once you complete these tasks and build your file collection, you can install it on the machines in your system. You can also install a file collection from a server other than its default server.

You can find advanced file collection tasks on pages 159 through 161.

Reporting File Collection Information

supper has subcommands that report information about file collections. These subcommands are useful for verifying information before performing file collection manipulations or for checking results at some point during a procedure.

The following table shows the **supper** subcommand to use, where you would run the command, and the data you can report. See the book *PSSP: Command and Technical Reference* for additional command options.

Use:	On:	To Report This Data:
status	Control workstation, boot/install servers, and nodes	Name, resident status, and access point of all available file collections, plus the name and estimated size of their associated file systems
files	boot/install servers and nodes	All the resident files resulting from a **supper update** or **install** command
serve	Control workstation and boot/install servers	All the collections that can be served from your machine
where	Boot/install servers and nodes	Current boot/install servers for collections
when	Boot/install servers and nodes	Last update time of all resident collections
diskinfo	Control workstation and boot/install servers	Available disk space and active volume for your machine
log	Boot/install servers and nodes	Summary of the current or most recent **supper** session
rlog	Boot/install servers and nodes	Raw output of the current or most recent **supper** session

The following examples show the output produced by some of these commands.

From the Control Workstation:

```
[tserv11][/]> supper status

 Collection          Resident  Access Point         Filesystem         Size
==============================================================================
 node.root              -      /                        -                 -
 power_system           -      /share/power/system      -                 -
 sup.admin              -      /var/sysman              -                 -
 user.admin             -      /                        -                 -
==============================================================================
```

From a boot/install server:

```
[r05n01][/]> supper status

 Collection          Resident  Access Point         Filesystem         Size
==============================================================================
 node.root             Yes     /                        -                 -
 power_system          Yes     /share/power/system      -                 -
 sup.admin             Yes     /var/sysman              -                 -
 user.admin            Yes     /                        -                 -
==============================================================================
```

From a processor node:

```
[r05n10][/]> supper status

 Collection          Resident  Access Point         Filesystem         Size
==============================================================================
 node.root             Yes     /                        -                 -
 power_system           -      /share/power/system      -                 -
 sup.admin             Yes     /var/sysman              -                 -
 user.admin            Yes     /                        -                 -
==============================================================================
```

Example of a **supper where** command:

```
[r05n01][/var/sysman/sup/node.root]> supper where
supper:  Collection node.root would be updated from server r05cw.
supper:  Collection power_system would be updated from server r05cw.
supper:  Collection sup.admin would be updated from server r05cw.
supper:  Collection user.admin would be updated from server r05cw.
```

Verifying File Collections Using scan

The **scan** file provides an inventory of all the files and directories in the file collection. By looking at the **scan** file you can quickly see which files are in a collection. You can find the **scan** file in the file collection's directory in **/var/sysman/sup**.

Although **scan** files require maintenance whenever files are added, deleted, or changed in the master collection, they save processing time on larger file systems.

Note

You must update the **scan** file each time you modify the file collection or you risk accidentally updating the collection from an outdated master file.

Example

To check for an existing **scan** file in the **user.admin** file collection, enter:

```
ls /var/sysman/sup/user.admin
```

To create a **scan** file for the **user.admin** file collection, enter:

```
/var/sysman/supper scan user.admin
```

Following is a sample of a **scan** file for the **user.admin** collection. It shows the name of each file preceded by three sets of numbers. The first set is the file permissions, the second set indicates when the collection was installed, and the third set indicates when the collection was last updated.

```
V2
100644 898550069 898291329 etc/amd/amd-maps/amd.u
X/etc/amd/refresh_amd
100644 902502604 902502321 etc/auto.master
100644 902499005 902495923 etc/auto/maps/auto.tstauto
100644 898550069 898291329 etc/auto/maps/auto.u
X/etc/amd/refresh_amd
100664 903622203 903620838 etc/group
100664 903622203 903621192 etc/passwd
100664 903625802 903624000 etc/passwd.id.idx
100664 903625802 903624000 etc/passwd.nm.idx
100640 903622203 902858646 etc/security/group
100644 903622203 903620838 etc/security/passwd
100644 903622203 903620838 etc/security/passwd.idx
```

Note

There are special considerations when using scan files in an HACWS environment. In this environment, a control workstation can be either a file collections client or a server depending on whether it is active. Refer to "Managing File Collections" on page 339 for more information.

Updating Files in a File Collection

The SP file collections can be used to contain system control files that you will need or want to change. When you update files that are part of a file collection, you do not have to make the same update on each replication of the files. Instead, you make the update to the copy on the master server for that collection and run the **supper update** command on all systems you want updated. The **supper** program does the updates for you.

The **supper update** command is included in the **crontabs** file with the default set to run hourly. You can modify the **crontabs** file to run the **supper update** more or less frequently. Refer to Chapter 13, "Maintaining the crontabs File" on page 217 for more information.

Step 1: Make the Changes to the Files

1. **Be sure you are working with the master files.**

   In a file collection there are many replications of the same file. It is possible for copies of a file to exist on the control workstation, on several boot/install servers, and on all the processor nodes.

   In the default system, the control workstation is the master server for all file collections. If you have not changed anything in this configuration, this is where you will always make updates.

   Note

   If you changed the default configuration, be aware of the hierarchy of servers in your system and be sure you are modifying the copy of the file that is on the master server for the collection.

   See "File Collections Organization" on page 142 to review file collection hierarchy.

2. Change the files as appropriate.

Example

In our default configuration, the master files for all file collections are on the control workstation.

Log in to the control workstation as **root** and copy a new version of **/.profile** into the **/share/power/system/3.2** directory.

Step 2: Run the supper scan Command

To keep the **scan** file current, you must run the **supper scan** command on the master collection every time you make a change.

Example

Run the **supper scan** command on the control workstation. Enter:

```
/var/sysman/supper scan power_system
```

Step 3: Run the supper update Command

You need to run the **supper update** command in every location that the collection is installed and where you want the change to be effective. For example, if you change the files on a server that is the master for eight processor nodes and you want each node to have the changes, you need to run the update on all eight nodes.

You can accomplish this update in several ways:

1. You can wait for the scheduled update. The **supper update** command is included in the **crontabs** file to be run on a scheduled basis.
2. You can issue the commands immediately, logging in to each machine or remotely issuing the commands with **rsh** or **rexec**.

Example

1. Log in to each server requiring the update. The **.profile** file is in the **node.root** collection as a secondary collection available within the **power_system** collection. This means on the boot/install servers you update the **power_system** collection. Enter:

   ```
   /var/sysman/supper update power_system
   ```

2. Log in to each of the nodes requiring the update. On the nodes you update the **node.root** collection. Enter:

   ```
   /var/sysman/supper update node.root
   ```

3. Check the **supper** messages. **supper** returns the number of files updated, removed, and the number of errors produced as shown in this message which was returned after changing **.profile** and performing the update on a processor node.

   ```
   ===================================================================
   [r02n07][/]> supper update node.root
   Updating collection node.root from server mrcs-r1.
   File Changes:  1 updated, 0 removed, 0 errors.
   ===================================================================
   ```

   supper also writes summary messages to the following file:

   /var/adm/SPlogs/filec/sup.<**month**>**.**<**day**>**.**<**year**>**.**<**hour** >**.**<**min**>

   Detailed information is written to the following file:

   /var/adm/SPlogs/filec/sup.<**month**>**.**<**day**>**.**<**year**>**.**<**hour**>**.**<**min**>**.r**

   File collection log files older than 48 hours are removed at midnight by a **crontab** entry. To see all the messages in the log, you have to display or print the **logs** file. You can check the **supper** log for messages from the last install or update using a **supper** command. The following example shows a **supper update**, followed by a **supper rlog** command:

   ```
   [r05n01][/var/adm/SPlogs/filec]> supper update node.root
   Updating collection node.root from server r05cw.
   File Changes:  2 updated, 0 removed, 0 errors.


   [r05n01][/var/adm/SPlogs/filec]> supper rlog
   SUP 7.24 (4.3 BSD) for file /tmp/.sf13689 at May  6 12:01:57
   SUP Upgrade of node.root at Fri May  6 12:01:57 1994
   SUP Fileserver 7.12 (4.3 BSD) 26295 on r05cw.hpssl.kgn.ibm.com
   SUP Locked collection node.root for exclusive access
   SUP Requesting changes since Fri May  6 12:00:07 1994
   SUP Receiving file .kshrc
   SUP Receiving file .profile
   SUP Upgrade of node.root completed at Fri May  6 12:01:58 1994
   ```

Granting Permission to Obtain a File Collection

Permission to obtain file collections that are standard with the SP system software is automatically granted to SP nodes. You can choose to grant permission for these file collections to non-SP hosts as well. You can also create your own file collections and control distribution of them.

Automatic Permissions for SP Nodes

During the configuration of file collections, a per-collection **host** file is created to limit access for the IBM-defined collections to the nodes of the SP system. The file resides in the directory **/var/sysman/sup/***file_collection***/host**, where *file_collection* is the unique name of a file collection. The file collections server, supfilesrv, uses this file when checking whether a host has been granted access to obtain the collection in which the **host** file resides. The file collections server runs on the control workstation. If your SP system uses boot/install servers, the file collections server also runs on each node that is a boot/install server. Therefore, the per-collection **host** file is created and maintained on the control workstation and any boot/install servers you have defined.

The **host** file is updated with the hostnames of the adapters in the SP system as found in the SDR. The file is updated during the following events:

- configuration
- reboot of the server host
- addition of node
- deletion of node
- addition of adapter
- deletion of adapter
- definition of boot/install server
- failover of the control workstation by HACWS

The **filec_host** command is run periodically to update the per-collection **host** file. Only the host names of the adapters in the SP system are automatically maintained in the file. They can be distinguished by the special comment:

```
#generated_entry_donot_edit
```

These generated entries should not be deleted. You can add names of other non-SP hosts to the **host** file to permit those hosts access to the SP file collections. It is your responsibility to set up the proper client on the non-SP hosts using the **SUP** public code that comes with the SP software.

The **filec_host** command reads the **/var/sysman/collection.host.list** file to obtain a list of the collections for which the **host** file must be created or updated. The **collection.host.list** file contains the names of the IBM-delivered collections by default. If you have collections in the **/var/sysman** path that you want to define and distribute to SP nodes, you need to add their names to the **collection.host.list** file so that the **host** file gets created and updated for the SP nodes to be granted access to them. The **collection.host.list** file is distributed through the SP **sup.admin** file collection.

The **host** file is not automatically distributed. Distributing the **host** file through the file collections server would place the file on the nodes as well as any boot/install servers. Although this is not a security risk since the file collections server does not normally run on the nodes, whether you want to distribute the **host** file is up to you. If you do want it distributed, see “Distributing the Per-Collection Host File” on page 152.

Granting Permissions to Non-SP Hosts

To grant permission for obtaining a file collection to a non-SP host, edit the **/var/sysman/sup/***file_collection***/host** file and add the name of the host to which permission is granted. The file should be updated on the host that services the requests for the respective collections. This could be the control workstation or an SP node that is a boot/install server. Depending on the number of host names (one per adapter) on the host being granted permission, you might need to add more than one host name for the host.

Since the **host** file grants permissions to only one collection, the collection of which it is part, you might need to edit the **host** file for each collection to add the non-SP hosts so that the non-SP host can obtain all collections.

Do not remove the entries with the specially generated comments. They are automatically generated to grant the SP nodes access to the IBM-delivered file collections. You can add your own entries anywhere in the per-collection **host** file. However, when the file is automatically updated, all customer entries are placed at the top of the file and are followed by all the SP-generated entries.

Distributing the Per-Collection Host File

If you plan to distribute the per-collection **host** file using the file collections server, you must make all updates to these per-collection **host** files on the control workstation. They get distributed to all boot/install servers (as well as the nodes and other hosts you might have added), overwriting any **host** files that might reside there. If you have edited the **host** file on a boot/install server rather than on the control workstation, you will lose those changes when the file gets distributed from the control workstation.

The per-collection **host** file can be distributed through the file collections server by adding the following to the **/var/sysman/sup/sup.admin/list** file:

```
always ./var/sysman/sup/*/host
```

Adding and Deleting Files in a File Collection

Adding and deleting files in a file collection are a bit more complicated than adding and deleting files in a standard directory. The **prefix, list,** and **refuse** master files contain criteria that define which files are in a particular collection. The master files are read and processed by the **scan, install**, and **update** commands. When you add or delete files in a file collection, you need to review the contents of these master files. For more information about the master files and how they work, see “Building a File Collection” on page 154.

The examples in this section show how to add the **/etc/environment** file to the **node.root** collection.

Step 1: Add or Delete Files in the File System

1. **Be sure you are working with the master files.**

   The same considerations you make to update files also apply here. Verify that you are on the machine that is the master server for the collection you are changing. See “File Collections Organization” on page 142 to review file collection hierarchy.

2. Add or delete files in the file system using standard AIX file commands.

   When adding files, you need to consider whether the files are in a primary or secondary collection, what the **prefix** and **list** files in that collection contain, and the position of the new files in the file tree. Remember, the **supper** commands begin their search starting at the point defined in the **prefix** file. For any file collection on an SP host, this is the root (/) directory. All files encountered that pass the criteria defined in the **list** file are considered part of the file collection.

Examples

1. To add a file to the **node.root** collection which is a secondary collection under the **power_system** collection, you would copy the file to the **/share/power/system/3.2** directory. The **/var/sysman/sup/node.root/prefix** file shows that the directory search for this collection begins at **/share/power/system/3.2**. The **/var/sysman/sup/node.root/list** for this example contains the following:

   ```
   symlinkall
   omit    ./usr
   upgrade .
   ```

   The entry **upgrade .** indicates that ***all*** files encountered in the **/share/power/system/3.2** directory during the search are to be upgraded.

   To add **/etc/environment** in our default configuration, log in to the control workstation and copy **/etc/environment** to the **/share/power/system/3.2** directory:

   ```
   cp /etc/environment /share/power/system/3.2/etc/environment
   ```

2. To add a file to the **user.admin** collection, you would proceed differently. The **/var/sysman/sup/user.admin/prefix** file shows that the directory search starts at the root of the file tree, therefore, the directory search would find the **/etc/environment** file. The **/var/sysman/sup/user.admin/list** file shows that only those files specifically listed will be upgraded instead of the entire directory.

   In this case, you do not need to copy the file. Instead, add a specific entry to the **list** file to upgrade it.

Note

To add a file to a collection, the file must permit others to have read access.

To delete a file from a file collection, either remove it on the master server or delete its entry in the **list** file and proceed with the other steps in this task.

For example, to remove **/etc/environment** from the **node.root** collection, log in to the control workstation and enter:

```
rm /share/power/system/3.2/etc/environment
```

Step 2: Run the supper scan Command (optional)

The **scan** is not a required file and not all file collections have one. Check the file collection directory to see if the collection you are updating has a **scan** file.

- If you have a **scan** file in this collection and you want to maintain it, you must run the **supper scan** command on the master collection every time you make a change. When a **scan** file is present, the **update** command reads it as an inventory of the files in the collection and does not do the directory search.

  You also have the option of deleting the **scan** file and allowing **supper** to process the file collection without it.

  Note

  If you keep the **scan** file and fail to run the **supper scan** command when you add files, the **scan** file will not be current and the new files will not be included in the collection.

- If you do not have a **scan** file in this collection, the **update** command will search the directory, apply the criteria in the master files, and add the new file.

Example

1. Run the **supper scan** command on the control workstation:

   ```
   /var/sysman/supper scan power_system
   ```

   This builds a new **scan** file for the collection.

2. Check the **scan** file to verify that it contains the additional **/etc/environment** file.

Step 3: Run the supper update Command

Run the **supper update** command everywhere you want this change to be effective. See "Step 3: Run the supper update Command" on page 149 for your options in performing this step.

Example

1. Log in to each server requiring the new file. The **/etc/environment** file is in the **node.root** collection as a secondary collection available within the **power_system** collection. Enter:

   ```
   /var/sysman/supper update power_system
   ```

2. Log in to each of the nodes requiring the new file. On the nodes you update the **node.root** collection. Enter:

   ```
   /var/sysman/supper update node.root
   ```

3. Check the **supper** messages to verify the updates worked.

Building a File Collection

Once you become familiar with file collections and have worked with the delivered system collections, you might want to create your own. You can build a file collection for any group of files that you want to have identically replicated on nodes and servers in your system. These file collections must all reside on the control workstation or a boot/install server. Some good candidates for file collections are application data files or local tools.

The basic procedure to build a file collections is:

- Begin by logging in as **root** to the server where the files reside.
- Create the directory and create a set of master files by copying them from an existing file collection. The master files define the rules for including and excluding files in the collection.
- Optionally, run the **supper scan** command to search the file tree, apply the rules, and build a **scan** file.
- Set up a link in the **/var/sysman/sup/lists** for the new file collection's **list** file.
- Add an entry to the **file.collections** file to define the file to the **supper** program.

After you build your file collections, you can install them on other servers or nodes.

This section provides examples showing you how to build a primary file collection for a set of local tools in the **/usr/local** directory for the control workstation and boot/install servers.

Related Information

Before you build a file collection of your own, be sure you understand the directory and master files, what they contain, and how they work. Refer to “Understanding File Collections” on page 138 if you need to review these concepts.

Step 1: Identify the Files You Want to Collect

The files you want to collect as a group must all reside on the same system from which you want to serve this collection and their permissions must allow them to be readable by everyone.

Example

In this example, the files will be served from the control workstation so they must all reside there in **/usr/local**.

Step 2: Create a File Collection Directory

Create a directory in **/var/sysman/sup** that will be the name of your file collection and change its owner and group to **bin**.

Example

This file collection will be called *tools*.

```
cd /var/sysman/sup
mkdir tools
chown bin tools
chgrp bin tools
```

Step 3: Create a list File

Create a **list** file to describe the rules for including and excluding files in that directory. Refer to “supper list File Syntax, Keywords, and Operands” on page 162 for details.

Example

The easiest way to create these files is to copy them from an existing file collection directory, delete those you do not need or the system creates, and modify them as required.

```
cp —p sup.admin/* tools
   cd tools
   rm when last scan
```

Modify the **list**, adding these commands:

```
   symlinkall
   omitany *
   omit ./usr/local/admin
   upgrade ./usr/local
   always ./usr/local/admin/control_file
   execute /usr/local/refresh_fonts (./usr/local/fonts)
```

This instructs **supper** to:

- Copy links rather than resolve them
- Omit files that start with the backup notation
- Omit administrative tools
- Upgrade all files in the local tools directory
- Override an omit instruction and always update the control file
- Execute the script to refresh the font library whenever the **/usr/local/fonts** file is changed

Step 4: Add a Link to the lists File

The **lists** file in the **/var/sysman/sup** directory contains a symbolic link to the **list** file in each file collection. When you create a new file collection you must add a link to this file.

Example

Add a link pointing to the **list** file in the *tools* collection:

```
   ln -s /var/sysman/sup/tools/list  /var/sysman/sup/lists/tools
```

Step 5: Update the file.collections File

Edit **/var/sysman/file.collections** using your text editor. Add the name of your new file collection as either a primary or secondary file.

Example

The *tools* collection is a primary collection and requires an entry similar to **server.root**. Edit **/var/sysman/file.collections** and add these lines to the end:

```
# tools - boot/install collection to manage local tools files on the file servers
primary tools - / - / EDO power no
```

The nine fields in this entry have specific meaning to **supper**:

Field 1 Defines the file as a primary or secondary collection

Field 2 Specifies the name of the file collection

Field 3 For a primary collection, this specifies the name of the file system associated with the collection. This file system will be created when the file collection is installed. For a secondary collection, this specifies the name of its primary collection. The notation (-) indicates no file system will be created or that it is a secondary collection.

Field 4 Specifies the name of the directory by which the files are normally accessed. For any file collection on an SP host, this includes the root (/) directory.

Field 5 If the collection has a file system, this specifies the file system size. The notation (-) indicates no file system is associated with this collection or that it is a secondary collection and the file system is associated with its primary collection.

Field 6 Specifies the prefix directory at which the **scan** process starts. For any file collection on an SP host, this is the root (/) directory.

Field 7 Specifies SUP options. In our example,

- E allows **list** file **execute** statements
- D deletes files that no are longer in the collection.
- O indicates that all files (even those older than the last update) should be evaluated.

Field 8 Specifies the system architecture. **power** indicates RS/6000 architecture.

Field 9 Specifies if this file collection can be installed on a different architecture.

Step 6: Update the .resident File

The **.resident** file contains a list identifying all the SP file collections. Edit the **.resident** file on each node and boot install server on which the file resides and add your new collection.

Example

Add the tools file collection to the **/var/sysman/sup/.resident** file:

```
sup.admin 0
user.admin 0
power_system 0
tools 0
```

Step 7: Build the scan File (optional)

The **scan** file provides you with a list of files in the collection that you can use for verification and eliminates the need for **supper** to do a directory search on each update. If your directory tree is extensive, this can save processing time on large file systems.

Note

You must keep the **scan** file current. When a **scan** file is present, the **update** command reads it as an inventory of the files in the collection and does not do the directory search. If you fail to create a new **scan** file when you add, modify, or delete files in the master collection, the file will not be current and **supper** will not upgrade the collection correctly.

Example
To create a **scan** file for the tools file collection, enter:

```
   /var/sysman/supper scan tools
```

Installing a File Collection

During the initialization and customization process, the required SP file collections are first built on the control workstation and then installed on your boot/install servers and processor nodes. If you create your own file collections you have to install them yourself on each server or node.

To install a collection on a boot/install server or processor node, you must be logged in as root or issue remote commands to run **supper** there.

Step 1: Update the sup.admin File Collection

The **sup.admin** file collection contains the files that identify and control all the file collections. It contains the **file.collections** and **.resident** files. Whenever you make changes to these files, you need to update the **sup.admin** collection to distribute these updates.

You can wait for the scheduled update in the **crontabs** file or issue the command yourself on every boot/install server and node that needs the new collection.

Example
Log in to each boot/install server and node or issue the command remotely and enter:

```
/var/sysman/supper update sup.admin
```

Step 2: Run the supper install Command

Run **supper install** on each boot/install server or node that needs this collection. The **install** command assumes the dedicated server to be the default.

Example
In this example, the tools file collection will only be installed on the boot/install servers and not the processor nodes.

Log in to each boot/install server or issue the command remotely and enter:

```
   /var/sysman/supper install tools
```

Step 3: Add the supper update to crontabs

You need to add the **supper update** command to the **crontabs** file on each server or node that has this collection. This insures that the new collection will be updated on schedule with the other file collections.

Example
To add the command so it runs hourly, edit **crontabs** and add this line:

```
   0 * * * * /var/sysman/supper update tools 1>/dev/null 2>/dev/null
```

Until the update runs, the files will not be available at each location. If you need the files on these systems before the scheduled update, you can issue the update command on each server and processor node yourself.

Example
Log in to each boot/install server or issue the command remotely, and enter:

```
/var/sysman/supper update tools
```

Refusing Files in a File Collection

The **refuse** file allows you to customize the file collection at different locations. It is possible for you to create a file collection with one group of files and have different subsets of that group installed on the boot/install servers and the processor nodes.

You do this by creating a **refuse** file in the **/var/sysman/sup** directory on the boot/install server or processor node. This master file lists all the files in every file collection that you do not want installed or updated on that system.

Example

In this example, we want one boot/install server to have the full file collection including the test files and another to have the boot/install collection minus the test files. Log in to the boot/install server that should not have the test files and create a **refuse** file with the following entries:

```
/usr/local/draw.test
/usr/local/crunch.test
```

This instructs **supper** to never include these test files when installing or updating this file collection *at this location.*

Note

There are two kinds of **refuse** files. One is in the **/var/sysman/sup** directory and contains the files that will not be installed on that server or node. These **refuse** files are optional, are user-created, and can vary at each location. The other **refuse** file is in the file collection's directory and contains a list of all the files refused when the file collection is installed or updated. This **refuse** file is system-created and might be empty if you always install the entire collection.

Modifying the File Collection Hierarchy

The delivered file collections have a default hierarchy shown in Figure 3 on page 142. You can modify the hierarchy in several ways. One way is to make a given boot/install server function as the master server for a collection. This enables you to maintain a different set of files on a group of nodes that request their **supper** updates from that boot/install server. You do this by eliminating the logical path from the control workstation to the boot/install server for one or more boot/install collections. This is called taking the boot/install server *offline* and you do it with the **supper offline** command. Figure 6 on page 160 shows a boot/install server that is offline for the **power_system** collection.

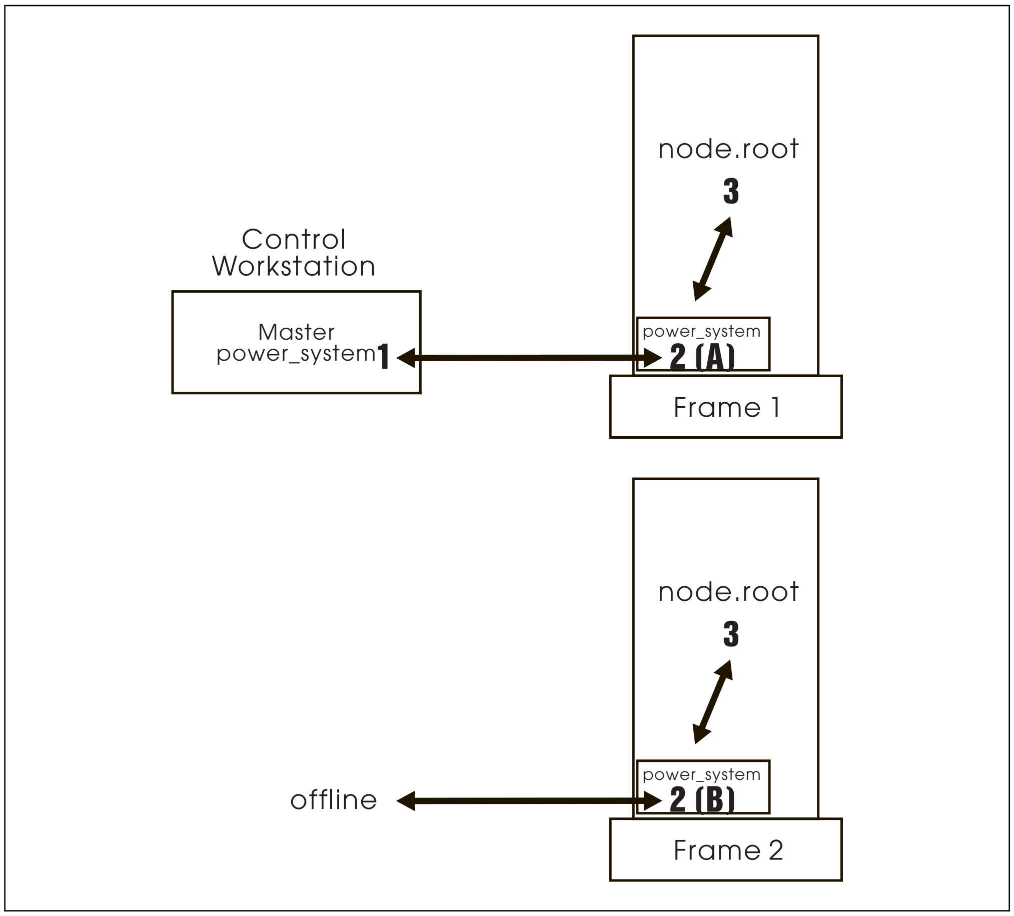


Figure 6. SP Hierarchy of an Offline Boot/install Server

In this case, Boot/install Server A and Frame 1 get any changes made on the control workstation; Boot/install Server B and Frame 2 do not. Only changes made directly to the files on Boot/install Server B affect the files on Frame 2.

Note

Whenever you change the hierarchy, you must be aware of the location of the master files for every file collection. In Figure 6, there are two master file collections for **power_system**. The master files for the **node.root** collection on Frame 2 reside on Boot/install Server B and the master files for the **node.root** collection on Frame 1 reside on the control workstation.

- If you want to change a file in the **node.root** collection for every node, you must make that change in two places, on Boot/install Server B and on the control workstation, and then run the **supper update** command on each node.
- If you want to change a file in the **node.root** collection for just one frame of nodes, you must make that change in the master file collection for that frame, either Boot/install Server B or the control workstation, and then run the **supper update** command on each node in that one frame.

The following example shows you the procedure and commands to change the default hierarchy as represented in Figure 3 on page 142. It shows you how to take the **power_system** collection offline, change a file in the **node.root** file collection, and distribute that update to the nodes on Frame 2.

Example

This example assumes that **.profile** is in the **node.root** file collection.

1. To take the boot/install server offline from the control workstation, log in to Boot/install Server B as **root** and enter:

   ```
   /var/sysman/supper offline power_system
   ```

2. On Boot/install Server B, modify the **.profile** in the **/share/power/system/3.2** directory.

   Remember, any changes made on the control workstation will not be updated on Boot/install Server B because it is offline. You must make the changes on Boot/install Server B.

3. Issue remote commands to update the **node.root** file collection on each of the nodes.

   ```
   /var/sysman/supper update node.root
   ```

4. Boot/install Server B no longer gets updated files from the control workstation. Unless you remove the **supper** command to update the **power_system** from the **crontabs** file on Boot/install Server B, the command will execute every hour and fail. Edit the **crontabs** file and remove:

   ```
   0 * * * * /var/sysman/supper update power_system 1>/dev/null 2>/dev/null
   ```

Removing a File Collection

Warning: Never remove any of the file collections that come with the SP system!

The file collections that come with the SP system are required. If you remove them, the System Support Programs cannot run properly.

Removing a file collection does not delete it. It removes it from the place it was installed. To completely delete a file collection, you must remove it from every place it was installed. Be sure you do not need any files in a file collection before you remove it.

You can use the **supper scan** command to build a **scan** file for the file collection you are going to remove. The **scan** file shows you a list of all the files in a collection. You can check it to verify that you do not need any of these files before you remove the collection. See “Verifying File Collections Using scan” on page 147 for more information about the **scan** file.

Example

To build a **scan** file for verification, enter this command on the boot/install server where the *tools* collection is installed:

```
/var/sysman/supper scan tools
```

If you are sure you do not need any of the files, continue with the next command.

To remove the *tools* boot/install collection, on the same boot/install server enter:

```
/var/sysman/supper remove tools
```

This removes all the files in the collection only from that machine. If you also issue this command on the control workstation or the master server for the collection, you will no longer be able to propagate these files in your system.

supper list File Syntax, Keywords, and Operands

The following commands are used in the **supper list** file to define which files in a directory to include or exclude from a file collection. Refer to “Directory and Master Files” on page 142 for information about the **supper list**.

Syntax Rules

- Each command contains a keyword and a number of operands separated by spaces.
- The order of the commands does not matter and you can include blank lines between the commands.
- *filename* can be a single file, directory, or a list of files or directories separated by blanks. The names can include wild cards and metacharacters as used by **csh**, including *, ?, [....] and {...}. The value for *filename* must be specified as a relative path, such as **./etc/passwd** or **./var/sysman**.

Command Keywords and Operands

- **upgrade** *filename*

  The specified files or directories are included in the list of files to be upgraded unless they are also specified by an **omit** or **omitany** command or are in the **refuse** file. If a directory name is given, it recursively includes all subdirectories and files within that directory.

- **always** *filename*

  The specified files or directories are included in the list of files to be upgraded, regardless of the **omit** or **omitany** commands. They will not be included if they are in the **refuse** file.

- **omit** *filename*

  The specified files or directories will be excluded from the list of files to be upgraded. For example, by specifying **upgrade ./usr/vision** and **omit ./usr/vision/exp**, the generated list of files would include all subdirectories and files of **./usr/vision** except **./usr/vision/exp** and its subdirectories and files.

- **omitany** *pattern*

  The specified patterns are compared against the files specified in the **upgrade** entry. If a pattern matches, the file is omitted. The **omitany** command currently supports all wild card patterns except {...}. Also, the pattern must match the entire file name, so a leading */, or a trailing /*, might be necessary in the pattern.

- **backup** *filename*

  The specified files are marked for backup. If they are upgraded, backup copies are created. Directories cannot be specified and no recursive file name construction is performed; you must specify the names of the specific files to be backed up before upgrading.

- **noaccount** *filename*

  The accounting information (permissions and time stamps) of the specified files is not preserved.

- **symlink** *filename*

  The specified files are to be treated as symbolic links. They are transferred as links and not followed. By default, symbolic links are followed. **symlinkall** transfers all symbolic links.

- **execute** *exec-command* (*filename*)

  The command specified is executed on the client process whenever any of the files listed in parentheses are upgraded. A special token, %s, might be specified in the command and is replaced by the name of the file that was upgraded. For example, if you use `execute ranlib %s (libc.a)`, whenever `libc.a` is upgraded, the client machine will execute `ranlib libc.a`..

- **include** *listfile*

  The specified *listfile* is read at this point. This is useful when one collection subsumes other collections; the larger collection can simply specify the files for the smaller collections contained within it.

Related Information

The *PSSP: Command and Technical Reference* presents the full **supper** command syntax with all the parameters and options. It also explains how to use **supper** in batch or interactive mode.

You can find additional information about **supper** and SUP in their manual pages.

Chapter 8. Managing User Accounts

In the SP system, you can use any user management facility that AIX supports. The PSSP software includes an SP user management facility. It supplies the SP user management commands **spmkuser**, **spchuser**, **sprmuser**, and **splsuser**. This chapter shows you how to add, change, delete, or list user accounts using both the SP commands and the SMIT interface.

Usage note:

To run the commands specified in this chapter, you must be logged in as the root user with write access to the SDR.

This chapter includes the following:

- Understanding the SP user management facility
- Adding user accounts
- Changing user accounts
- Listing a user account
- Removing user accounts
- Changing passwords
- Controlling user login

Understanding the SP User Management Facility

The SP system provides the ability for you to manage your user accounts by adding new users, deleting existing users, or changing the user account information from a single point of control. This optional SP user management facility ensures that users have the same account, home directory, and environment across all the nodes in the SP system.

The objective of any user management system is to ensure that the user account files, namely **/etc/passwd**, **/etc/group**, **/etc/security/passwd**, and **/etc/security/group** and optional password index files are consistent across all of your nodes. You can accomplish this by using Network Information Service (NIS), by distributing these files using file collections, or by some other means. The password index files **/etc/passwd.nm.idx**, **/etc/passwd.id.idx**, and **/etc/security/passwd.idx** are used for login performance.

If you use NIS, the SP system references the NIS maps that are located on the NIS master machine. The NIS maps provide each user with a single image of their user account information in the NIS domain. This information includes the user's login name, password, group information, default shell, and the name of the host where the home directory resides. If you use SP automounter support, the system also maintains automounter maps of mount points for the home directories. As the system administrator, you need to create and maintain the NIS environment on the NIS master machine in the **/var/yp** directory. The SP User Management commands do not interface with the NIS environment. For discussion of using NIS, refer to the appropriate NIS documentation or the book *IBM International Technical Support Centers RS/6000 SP System Management: Easy, Lean and Mean.*

If you are not using NIS, the SP User Management commands use the **user.admin** file collection to propagate the user administration files to the nodes of the system. You might want to use this file collection to keep other user management related files consistent across the nodes. For more information see "user.admin Collection" on page 141.

In NIS, users can change their own passwords, as needed, while logged in any SP node. In non-NIS environments users must log into the host where the password file resides. The full path name for the password file is set during installation by using the **passwd_file** parameter of the **spsitenv** command, SMIT panels, or the Set Site Environment TaskGuide. Administrators can change passwords for any user account from the NIS master.

After you complete the installation and customization procedures, you establish an initial set of users from the existing user management files in your network. The SP system provides the ability for you to manage your user accounts by adding new users, deleting existing users, or changing the user account information.

Note: When you set the SP user management Site Environment attribute to `true`, the configuration process renames the **/usr/bin/passwd** executable to **/usr/bin/passwd.orig**. In its place, a new **/usr/bin/passwd** executable is created. When you run it, it requests that you change your password on the control workstation.

Even though you use SP file collections, you can still use NIS in parallel for user administration. When you do use NIS, exclude the user administration files from the file collections and restore the **/usr/bin/passwd** executable (the original is stored as **/usr/bin/passwd.orig**).

SP User Management Options

Using the SP user management commands, you can add and delete users, change account information, and set defaults for your users' home directories. To use the SP user management options, you can specify them during the installation process, or change them later, by using SMIT panels, the **spsitenv** command, or the Set Site Environment Information Taskguide. The *PSSP: Installation and Migration Guide* contains detailed instructions for entering site environment information.

From SMIT

ENTER **smit enter_data**

- The Enter Database Information menu appears.

SELECT **Site Environment Information**

- The Site Environment Information menu appears.

The following options, displayed in the SMIT Panel for Site Environment Information, pertain to user management:

User Administration Interface
Whether or not you want to use SP User Management to add, delete, and change user account information.

Password File
The path of your password file. The user commands add, modify, and delete entries in this file. If you modify the default path of **/etc/passwd**

and you are using NIS, ensure that you also modify your NIS make file to build the password map from the new password file.

Password File Server Hostname
The hostname of the machine where your master password file resides. The initial value is the control workstation. The master password file location cannot be one of the nodes in the SP system.

Home Directory Server Hostname
The name or IP address of the machine where the user home directories reside.

You can specify a default host for users' home directories. If you use the SP automounter support the user management commands will use this host when building automounter maps to mount and link the home directories. If you do not specify a default, the initial value of the control workstation is assumed.

You can override the value in Hostname Home Directory Server when adding or modifying a user account with the **spmkuser** and **spchuser** commands.

If the users' home directories are served by a machine within the SP system and you follow the authentication setup described in Chapter 2, "Security Features of the SP System" on page 13, then you need not do anything more to have the SP user management commands run correctly.

However, if the home directory server is outside the SP system, there are two cases:

1. The machine that serves the home directory is in the same authentication realm as the SP system. In this case, the administrator's principal name must be added to the **.klogin** file of that machine.
2. The machine that serves the home directory is outside the realm and not authenticated. In this case, add a line to the **.rhosts** of the machine with the following data:
   - The hostname where the commands run
   - The user name **root**

   In this case, when the SP user management commands are run, informational messages are displayed to show that authenticated commands could not be run. However, the user management task will be performed.

Home Directory Path
This is where you specify the default path of users' home directories. The default is **/home/***control_workstation_name***/**.

Enter another value to set another path as the default for your site. You can override the default path with the **home** attribute, **spmkuser**, and **spchuser** commands.

Any host that is serving user directories must have its **/etc/exports** file modified to grant access to all hosts that need to mount these directories. Export the file systems using **exportfs -a** after modifying the **/etc/exports** file.

SP User Management Commands

The SP user management commands reside in the **/usr/lpp/ssp/bin** directory on the control workstation. You can add, change, delete, or list user accounts using either the SP commands or the SMIT interface.

For example, you can add new users to the SP system in any of the following ways:

- Enter the **spmkuser** command with the appropriate attributes and values.
- Enter **smit spmkuser**.
- Enter **smit**, select *Security & Users*, and then select *RS/6000 SP Users*.
- Enter **smit**, select *RS/6000 SP System Administration*, and then select *RS/6000 SP Users*.

The examples in this section show the first two methods. You can find the complete syntax for the commands in the *PSSP: Command and Technical Reference*.

Adding User Accounts

To add new users to the SP system with the SMIT interface:

TYPE **smit spmkuser**

- The Add a User window appears.

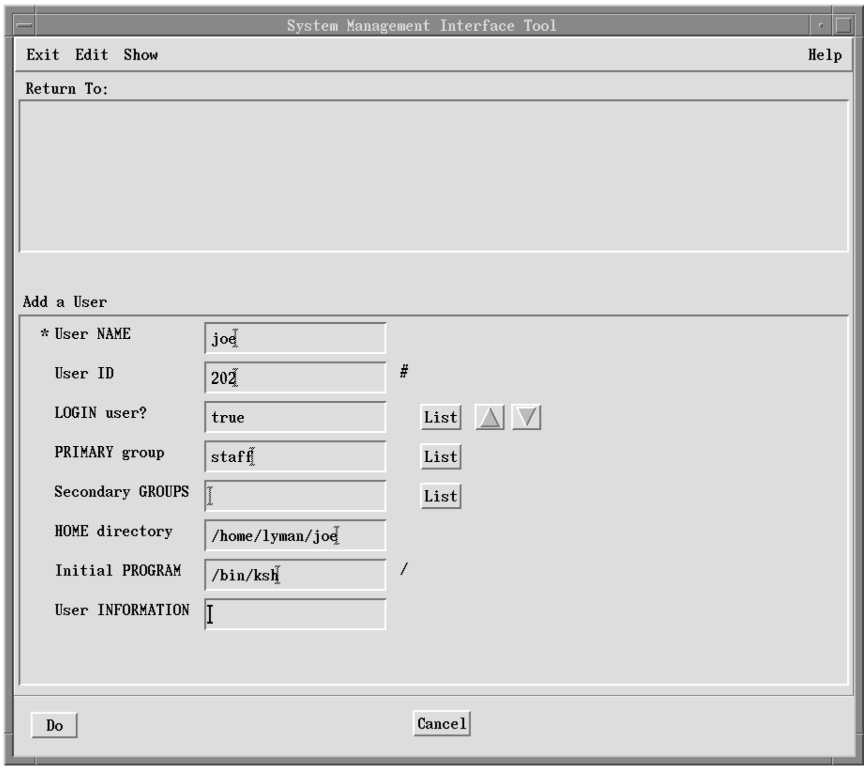
Only the *User name* is required. You can accept the defaults or leave the other fields blank. The defaults for primary group, secondary groups, and the initial program are in **/usr/lpp/ssp/bin/spmkuser.default**. The default for the home directory is stored in the System Data Repository. The following table shows how the fields in this window relate to the parameters in the **spmkuser** command.

SMIT Field	Command Parameter	Description
User name	Name	User login name
User ID	id	ID of the user
LOGIN user?	login	Indicates whether the user can login to the system with the **login** command. This option does not change the **/etc/security/user** file but instead alters the user's password field in **/etc/security/passwd**.
Primary GROUP	pgrp	Principle group of the user
Secondary GROUPS	groups	The groups to which the user belongs
HOME Directory	home	Host name of the file server where the home directory resides and the full path name of the directory separated by a colon
Initial PROGRAM	shell	Shell program run when the user logs in
User Information	gecos	General information about the user

When you add a new user, the system generates a random password for the user and stores it in **/usr/lpp/ssp/config/admin/newpass.log**. The **root** user has read and write permission to this file. It is the administrator's responsibility to communicate this password to the new user and periodically delete the contents of this file.

Example

The following example shows how to enter the information for a user named **joe** using SMIT:



* User NAME	joe
User ID	202 #
LOGIN user?	true
PRIMARY group	staff
Secondary GROUPS	
HOME directory	/home/lyman/joe
Initial PROGRAM	/bin/ksh /
User INFORMATION	

Figure 7. Example of Adding an SP User

TYPE The appropriate information in each field

PRESS **Do** to store the data.

To store the same information using the **spmkuser** command, enter:

```
spmkuser id=202 pgrp=staff home=lyman:/home/lyman shell=/bin/ksh joe
```

Changing User Accounts

To change user information with the SMIT interface:

TYPE **smit spchuser**

TYPE The name of the user whose information you want to change

- The Change/Show Characteristics window appears.

To change information, type the new values in the appropriate fields. The only field you cannot change is *User name*. You can scroll to see the information in the home directory field.

Example

To change information using SMIT:

TYPE	The new values
PRESS	**Do** to store the data.

To change the home directory for **joe** using the **spchuser** command, enter:

```
spchuser home=lyman:/home/lyman/joe joe
```

Removing User Accounts

To remove an existing user account from the SP system with the SMIT interface:

TYPE	**smit sprmuser**
TYPE	The name of the user whose information you want to remove • The Remove a User window appears.

You can choose to remove the user's home directory and the authentication data when **/etc/security/passwd** is utilized.

Example

To remove the **joe** user account with the **sprmuser** command but leave the authentication data and home directory intact, enter:

```
sprmuser joe
```

Listing a User Account

You can display the information for a user with the SMIT interface using **smit spchuser**.

TYPE	**smit spchuser**
TYPE	The name of the user whose information you want to view • The SP Change/Show Characteristics window appears.

Be sure to cancel after viewing the information.

You can also list user information using the **splsuser** command. For example to list information for a user named **ken** in colon-separated records, enter:

```
splsuser -c ken
```

Changing Passwords

| Your method of account management determines which steps are necessary to
| change passwords.

Changing Passwords for a File Collection System

If you use file collections rather than NIS, you must change the password in the master password file. Although this file may not be maintained on the control workstation, any changes to passwords must be made known to the control workstation.

1. Change password on host where master password file resides.
2. If the master password server is not the control workstation, copy the files **/etc/passwd** and **/etc/security/passwd** from the password server machine to the control workstation.
3. New password will be propagated throughout SP system within one hour.

Restricting the Use of the Control Workstation for General Users

If you use file collections on your system, users must be able to log in to the machine designated as the password file server to change their passwords. If you use the control workstation for the password server, you must allow users to log in to it to change their passwords. However, you may wish to have only administrative tasks performed on the control workstation, and therefore, do not want general users to be able to do anything other than change their passwords.

A script is provided that allows full login on the control workstation to the users you designate and restricts full login to all others. Users not designated can only log in to change their passwords and then are logged out. The script can be incorporated into the profile that is run during every login to the control workstation.

The script is located in **/usr/lpp/ssp/config/admin/cw_restrict_login**. To use the script, take the following steps:

1. Edit **/usr/lpp/ssp/config/admin/cw_allowed**

   The **cw_allowed** file defines to the **cw_restrict_login** script which user names are allowed to fully log in to the control workstation. **cw_allowed** is shipped containing three administrators' user names to show how the file should be formatted. These sample names should be removed from the file.

   Start each user name in the left most column and place one user name per line. Place no comments in the file. You do not need to list the root user in the file; the script is written to allow the root user to fully log in to the control workstation.

2. Integrate the restricted login script into the control workstation's login process by adding the following lines to the beginning (or at the most appropriate place) of the control workstation's **/etc/profile** file:

   ```
   # Allow general users to login to control workstation to only change
   # their password then log them out.
   /usr/lpp/ssp/config/admin/cw_restrict_login
   ```

   If you are using the AIX Common Desktop Environment (CDE) on the control workstation, you will also need to make a link from the restricted login script for CDE to the appropriate CDE directory:

   ```
   ln -s /usr/lpp/ssp/config/admin/cde_cw_restrict_login \
   /etc/dt/config/Xsession.d/cde_cw_restrict_login
   ```

3. Verify that you have set up correctly:

   a. Log in to the control workstation as root and make sure you can fully log in.

b. Log in as a user that should be allowed (listed in **cw_allowed**) to log in to the control workstation. Make sure this user can fully log in.

c. Log in as a user that is not allowed (not listed in **cw_allowed**) to fully log in to the control workstation. Make sure this user can change his password and then is logged out.

At any time you wish to remove this restrictive login, you can do so simply by commenting out (adding a # at the beginning of the script execution line) or by deleting the lines you added from the control workstation's **/etc/profile** file.

If you are using CDE and wish to remove its restrictive login, simply remove the **cde_cw_restrict_login** link you created in the **/etc/dt/config/Xsession.d** directory.

Changing Passwords on Systems without NIS or File Collection

If neither NIS nor file collection is used, you must distribute these updated password files across the SP system after you change the password.

1. **/etc/passwd**
2. **/etc/security/passwd**

Changing Passwords when SP User Administration Interface is Configured

If you have configured the SP USER ADMINISTRATION INTERFACE to **true** and you are not using NIS, the following base AIX commands are linked to SP commands on the nodes:

- **/bin/chfn** → **/usr/lpp/ssp/config/sp_chfn**
- **/bin/chsh** → **/usr/lpp/ssp/config/sp_chsh**
- **/bin/passwd** → **/usr/lpp/ssp/config/sp_passwd**

The original AIX files have been saved in their original location with extension **.aix** added. For example, the original AIX **passwd** command is in **/bin/passwd.aix**.

The linked **sp_** commands inform users what machine to log in to when, or if, they need to change password, gecos, or shell information.

Important Notes

1. Under certain circumstances, the user is prompted to change passwords during the login process. If this occurs, the user should log in to the machine serving the password file and make the change from there. If this is not done, the password change will be only local to the node; in addition, if File Collections is being used, the password change will be only temporary. To avoid this problem, communicate to users what machine to log in to when a password change is required during the login process. IBM suggests placing this information in the message of the day (MOTD).
2. If you de-install an AIX modification level after upgrading or rejecting an AIX PTF, the **lppchk** command will get run automatically. This command will show that the system is "broken" when it discovers the mismatch in file information for the AIX linked commands. This problem can be alleviated by following the proper procedure documented in the *PSSP Installation and Migration Guide*, section on Recovering from a Node Migration Failure, particularly steps 3 and 6.

Controlling User Login

Login Control is used to dynamically prevent interactive login of users on a node basis. Preventing interactive login of users on nodes running parallel jobs is desirable for performance purposes.

You may want to use Login Control to temporarily restrict all but a few users on a node for a specific purpose.

You can issue commands to temporarily restrict or unrestrict a user's interactive access to nodes running parallel jobs. The Login Control utility will not prevent LoadLeveler from running jobs submitted by blocked users because LoadLeveler logs in as **root** and then switches to the user. Root is never blocked on a node.

Understanding Login Control

User login completes successfully under AIX after checking attributes in the **/etc/security/user** file. The attributes are *login* and *rlogin*. If these values are set to `true`, the user is allowed to log in. Conversely, if these values are set to `false`, the user cannot log in. Login Control updates this file dynamically for a user or several users when a request is received.

The **spacs_cntrl** command takes four state keywords that manage user access to a parallel node:

1. **block**
2. **unblock**
3. **allow**
4. **deny**

Block and Unblock

These keywords are used by a System Administrator to dynamically restrict and unrestrict access to a node for a user or a group of users. These keywords are intended to set the user to a known state (either restricted or unrestricted) in the **/etc/security/user** file and in the **spacs_data** file.

Allow and Deny

These keywords can be used by a job submission system on a transactional basis to update the user state. Multiple usage of **spacs_cntrl** with one of these keywords for a user results in the request state being updated in **spacs_data**.

A user can be in one of four states when these keywords are used:

1. Allowed interactive login
2. Denied interactive login
3. Allowed login after a deny request
4. Denied login after an allow request

State 3 can occur when other jobs by this user are still running. A deny request removes one allow request: in this case, the first allow from the first job.

State 4 can occur when more than one deny request is issued for a user. A deny request removes one allow request.

A special file, **spacs_data**, is created when a user access change request is made more than once by a job submissions system using the keywords **allow** or **deny**. It can be said that this file holds the state of requests for a user. After the initial allow or deny request has been processed in **/etc/security/user**, the next allow or deny request sets a request count for the user. The same number of subsequent opposite requests will check the count, decrement it and remove the user, if present, from **spacs_data**. The use of the block and unblock keywords by the System Administrator updates **spacs_data**, clearing all multiple job submission system allow/deny requests for a user before changing the state in **/etc/security/user**. These keywords are intended to set the user to a known state (either restricted or unrestricted) in the **/etc/security/user** file and in the **spacs_data** file. The **spacs_data** file is owned by root and is located in the **/var/spacs** directory.

Login Control recognizes requests made with the **spacs_cntrl** command. (See the *PSSP: Command and Technical Reference* for syntax.) This command is run on each parallel node and can be used with **dsh** for this purpose.

Login Control uses a lock on the **spacs_cntrl.lock** file to prevent more than one instance of Login Control from updating the files. This file is created the first time the **spacs_cntrl** command is executed. This file also resides in the **/var/spacs** directory.

Types of Access Disallowed

When **spacs_cntrl** block or deny is used, all of the following types of interactive access are disallowed:

- **login**
- **rlogin**
- **rcp**
- **rexec**

- **rsh**

Disallowing ftp on a Node

As system administrator, you can disallow users from using **ftp** on a node by placing users in the **/etc/ftpusers** file. This file can be kept in a file collection and distributed to the appropriate nodes. The **ftp** daemon can also be disabled to prevent all ftp access.

You can also use the **ruser** command to manage **ftp** usage by a user on a node:

```
ruser -a -f username
```

Using this command with **dsh** to the appropriate nodes allows manipulation of the **/etc/ftpusers** file on a per user basis.

Using the Login Control Sample File

A sample Perl script called **block_usr_sample** is located in the **/usr/lpp/ssp/samples** directory. This script creates a file of user IDs, **/tmp/usr.input**, that can be used with **spacs_cntrl -f** to restrict user access. It serves as a model for formatting other files for use with the **spacs_cntrl** command:

```
userid1
userid2
userid3
```

Once you are familiar with Login Control, **spacs_cntrl** can be run within this script by removing the comments surrounding the command. A copy of this file is located in Appendix C, “Sample Files” on page 501.

Before using this script you must edit the **threshold UID ($uidstart)** in the script to be large enough so that system IDs and SP system IDs are not restricted. These IDs include **bin**, **admin**, **lpd**, **supman**, and **prtid**. The default threshold UID is set at 125. The **block_usr_sample** script can be added to the **script.cust** file or to the node's **inittab** file.

Adding the script to run from the **script.cust** file will create the **/tmp/user.input** file and run **spacs_cntrl block** when you install the node to initially restrict interactive access for all users. Users would remain in this state across a reboot unless specifically unrestricted by the System Administrator or by the job submission system. New users that are added to the system would not be included until the **block_usr_sample** script was run again at some later time.

Adding the **block_usr_sample** script to the **inittab** file will run this script at node boot time. This will include any new users on the node but may also increase the time to boot the node. This script must be added **AFTER** the **rc.sp** script in the **inittab** file. **rc.sp** removes the login control lock file, **spacs_cntrl.lock**, if present, when booting a node to ensure login control will run if a node is rebooted after a crash.

Using Login Control

There are many ways you can use login control on your SP system. You can restrict all or a subset of users on a parallel node to prevent the users from gaining interactive access. The restriction remains in effect until you specifically use the unblock keyword to unrestrict access for the restricted users.

This enables you to set aside a parallel node for the use of select users for interactive and parallel jobs. You can list the users on the command line or use a file containing the user names in a column. Note that this file must reside on the parallel node in order to be accessible to the login control command.

Restricting a User on a Single Node

To restrict user Betty on a particular node, on that node issue:

```
spacs_cntrl block betty
```

Restricting Users on Multiple Nodes

This example requires authority to run the **rsh** command on the nodes.

1. Run the **block_usr_sample** file after adjusting threshold UID.
2. Send the file to all the nodes that are currently responding.

   ```
   hostlist -av | pcp -w - -r root@mynode:/tmp/usr.input /tmp/usr.input
   ```

3. Issue login command to restrict interactive access for users to all the nodes.

   ```
   dsh -a spacs_cntrl -f /tmp/usr.input block
   ```

Maintaining Login Control

The following information is important for Login Control to function properly.

Since the **/etc/security/user** file is used by Login Control for state information, and by the AIX system for restricting and unrestricting login for users, this file is machine dependent and should not be overwritten. The **/etc/security/user** file should not be distributed through file collections or any other mechanism throughout the SP system.

The **spacs_cntrl** command may generate a large log file, depending on which flags you specify. The default for trimming the log file is 400 lines and is done every night through a **cron** job. If you wish to save the log for some reason, you can rename the file and a new log file will be created.

Usage Notes

You must issue the **spacs_cntrl** command to block new users added to a node if you have previously blocked all users on that node. Users denied login will see the standard message, “You have entered an invalid login name or password.”

Each time the log is opened, a date stamp is written. This might be followed by messages depending on the options chosen on the command line. The following **spacs.log** example shows the output when using the **-d** and **-l** flags on the **spacs_cntrl** command line.

Sample Log

```
"Tue Apr 26 10:11:47 EDT 1994"
spacs_cntrl:  Command Invocation: spacs_cntrl -d -l deny nancy.
spacs_cntrl:  CPFILE called for /etc/security/user and /etc/security/user.17008.
spacs_cntrl:  ACS_FILE/lock called for /var/spacs/spacs_data.lck.
spacs_cntrl:  List of users in deny list: .
spacs_cntrl:  List of users in allow list: ,mroz.
spacs_cntrl:  Deny processing.
spacs_cntrl:  List of users in send list: nancy.
spacs_cntrl:  MUSRFILE called.
spacs_user:  Called with parameters:  /usr/lpp/ssp/bin/spacs_user -l -d deny nancy.
spacs_user:  Attribute for user nancy changed to requested value.
spacs_cntrl:  List of users in return list: nancy:0.
spacs_cntrl:  CPFILE called for /var/spacs/spacs_data and /var/spacs/spacs_data.17008.
spacs_cntrl:  ACS_FILE/unlock called for /var/spacs/spacs_data.lck.
"Tue Apr 26 10:11:52 EDT 1994"
spacs_cntrl:  Command Invocation: spacs_cntrl -d -l deny pepper.
spacs_cntrl:  CPFILE called for /etc/security/user and /etc/security/user.20102.
spacs_cntrl:  ACS_FILE/lock called for /var/spacs/spacs_data.lck.
spacs_cntrl:  List of users in deny list: .
spacs_cntrl:  List of users in allow list: ,mroz.
spacs_cntrl:  Deny processing.
spacs_cntrl:  List of users in send list: pepper.
spacs_cntrl:  MUSRFILE called.
spacs_user:  Called with parameters:  /usr/lpp/ssp/bin/spacs_user -l -d deny pepper.
spacs_user:  Attribute for user pepper changed to requested value.
spacs_cntrl:  List of users in return list: pepper:0.
spacs_cntrl:  CPFILE called for /var/spacs/spacs_data and /var/spacs/spacs_data.20102.
spacs_cntrl:  ACS_FILE/unlock called for /var/spacs/spacs_data.lck.
```

Chapter 9. Managing Time Synchronization

There are several ways you might currently be handling synchronizing time-of-day clocks on your control workstation and processor nodes. You might already be using Network Time Protocol (NTP) either locally or through the Internet, or you might be using some other time service software. It is also possible that you have not established a method for synchronizing the system clocks in your computing environment.

The SP system gives you several options for time-keeping:

- If you have an established NTP time server, you can use it to synchronize and manage time on the SP system.
- You can choose an NTP time server from the Internet.
- You can run NTP locally on the SP system to generate a consensus time.
- You can choose to not use NTP at all, relying on other methods at your site. **If you choose to not use NTP, you must have another way to manage clock synchronization.**

Usage note:

To run the commands specified in this chapter, you must be logged in as the root user with write access to the SDR.

Managing NTP

There are three attributes set for NTP during installation, or you can change them later, by using SMIT, the **spsitenv** command, or the Set Site Environment Information TaskGuide. The *ntp_version* attribute defaults to a value of **3**, the version shipped with AIX 4.2 or later. That version of NTP is NLS-enabled. If your installation is using an earlier version of NTP, this value might need to be or might have been changed to represent the version in use. The other two attributes are described in Table 10 on page 180.

Table 10. Setting Time Service Choices

	The spsitenv Entries to Be Filled In	
To do this....	*ntp_config*	*ntp_server*
Use your site's existing NTP time server to synchronize the SP system clocks.	**timemaster**	*hostname* of your current NTP time server
Use an NTP time service from the Internet to synchronize the SP system clocks.	**Internet**	*hostnames* of time servers on the Internet*
Run NTP locally on the SP to generate a consensus time.	**consensus** (default)	
Do not use NTP on the SP. This means you are using some other independent method to synchronize system clocks.	**none**	

Note:

- Change default attribute values to suit your environment.
- Leaving an entry blank means that you make no substitution for the default value.
- * See**/usr/lpp/ssp/ssp.public.README** for information on Internet time servers.

When you choose any of the options that involve using NTP, the installation scripts determine the IP address of the host specified as **ntp_server** and create the **/etc/ntp.conf** file on each of the control workstation, boot/install server, and processor nodes. This file indicates which hosts can provide time service to which other hosts using the designations of *server* and *peer*, where:

server Indicates a host from which you can request time.

peer Indicates a host with which this host can synchronize time. Either peer host can request time from the other.

The following example shows a sample **/etc/ntp.conf** file:

```
# Server ip_addr version <ntp version>
server 9.8.77.66 version 3      # server is host_one.conrad.ibm.com
server 123.45.678.9 version 3   # server is host_two.ursula.ibm.com
peer 9.8.77.55 version 3        # server is host_x.conrad.ibm.com
peer 9.8.77.44 version 3        # server is host_y.conrad.ibm.com
peer 9.8.77.33 version 3        # server is host_z.conrad.ibm.com
```

Assuming this is the **/etc/ntp.conf** file on *your_host*, the following is true:

- *your_host* can request time from *host_one*, *host_two*, *host_x*, *host_y*, and *host_z*
- *your_host* can provide time, on request, to *host_x*, *host_y*, and *host_z*
- *your_host* cannot provide time to *host_one* or *host_two*.

The following table shows which host addresses will be used for servers and peers in the **/etc/ntp.conf** files created on the control workstation, file servers, and processor nodes for each **ntp_config** choice.

ntp_config	Control Workstation	Boot/Install Servers	Processor Nodes
`timemaster`	Server: Your time server Peer: All boot/install servers	Server: Your time server Peer: Control workstation Peer: All boot file servers	Server: Your time server Server: Control workstation Server: All boot file servers
`Internet`	Server: Internet server	Server: Control workstation Peer: Other boot file servers	Server: Control workstation Server: All boot file servers
`consensus`	Server: 127.127.1.10*	Server: Control workstation Peer: Other boot file servers	Server: Control workstation Server: All boot file servers
`None`	No file created	No file created	No file created
* This address signifies local time service to NTP and makes the control workstation a stratum 10 time server allowing you to hook into a higher stratum Internet time server at a later date.			

Related Information

For more information on the installation scripts, or to update the site environment, see the *PSSP: Installation and Migration Guide*.

Time Setting Options

To change time zones, use the AIX **chtz** *timezone_info* command. For example:

```
chtz EST5EDT
```

sets the time zone to Eastern Standard Time and 5 hours from Greenwich Mean Time and sets the machine to know about Daylight Savings Time.

Nodes and Control Workstations Out of Time Synchronization

Generally, time services adjust clocks incrementally to keep the clocks synchronized with the master clock. In cases when time is off by a large amount, like an hour in time zones that implement Daylight Savings Time, it becomes difficult and time-consuming to incrementally synchronize with the time master.

To ensure that clocks stay synchronized in that case, set nodes and the control workstation to understand Daylight Savings Time. See the **script.cust** sample file in the book *PSSP: Installation and Migration Guide* for information on setting time zones.

Chapter 10. Managing the Automounter

This chapter provides information on using an automounter on an SP system to manage the mounting of user home directories and other directories. Topics include:

- Understanding the automounter implementation
- Establishing an automount map for users' directories
- Using automount for other file systems
- Customizing the SP automounter function

For more information on the AIX automount daemon that is shipped as part of NFS in the AIX Network Support Facilities of the Base Operating System (BOS) Runtime, refer to *IBM AIX Version 4 System Management Guide: Communications and Networks*.

Usage note:

To run the commands specified in this chapter, you must be logged in as the root user with write access to the SDR.

Understanding the Automounter Implementation

An automounter is a facility used to manage the mounting activity of a file system. When you access a file or directory under automounter control, the automounter transparently mounts the required file system. When there has been no activity to that file system for some pre-determined amount of time, the automounter unmounts the file system.

Automounters are typically used with the Network File System (NFS). NFS is a distributed file system that allows you to access files and directories located on remote systems and treat those files and directories as if they were local. When performing its mounting activity for an NFS file system, the automounter uses the NFS mounting facilities. The automounter reduces the period of time that a file system is actively mounted, thereby minimizing local system hangs due to NFS server outages.

On an SP system, the automounter is optionally used to manage mounting of user home directories and other directories. When configured, an automounter daemon runs on each node and is started at the time the node is booted. It mounts directories on demand and unmounts them after a period of inactivity. The mounted directories can come from SP boot/install servers or any workstation or server in the network, including local directories on that node.

The automounter manages directories specifically defined in automounter map files. Typically, there is one map file for each file system to be controlled by the automounter. The map files contain entries for each directory supported within the file system and the specific mount information for that directory. If SP User Management services have been configured, the SP creates and maintains a map file to control user home directories in the **/u** file system.

Requesting SP Automounter Support

You can choose to allow the SP to use an automounter to provide remote access to users' home directories or you can rely on other methods of automounting or file system management established at your site. You specify your choice by setting the automounter configuration site environment variable **amd_config** when defining your site environment. You can specify your choice for the **Automount Configuration** variable on the Site Environment Information SMIT panel, using the Set Site Environment Information TaskGuide, or using the **spsitenv** command on the control workstation. If **amd_config** is `true` (the default setting), the SP does the necessary directory and file configuration, and starts the automounter daemon. If SP User Management services have also been configured (the **usermgmt_config** site environment variable is `true`), the SP adds, removes, and changes entries in the automounter map file for the **/u** file system to maintain user home directory information when SP users are added, removed, or changed.

If you set **amd_config** to `false` when you initially install the SP system, it will not configure or start the automounter daemon and it will not maintain user home directory information in automounter map files. You can change the initial setting of **amd_config** at a later time using SMIT, the Set Site Environment Information TaskGuide, or the **spsitenv** command. However, this change will not affect the running state of the automounter daemon until the next time you reboot your nodes or control workstation or take other actions to start or kill the daemon. Note that if **amd_config** is initially `false` and then later set to `true`, all user management changes that had occurred while **amd_config** was `false` will not be reflected in the automounter map file for user home directories and that information may need to be manually added. If you choose to unconfigure the automounter by changing **amd_config** from `true` to `false`, make sure that all user home directories, as well as other directories previously served by the automounter, are distributed and made available by some other means.

When **amd_config** is `true`, the SP system uses the AIX automount daemon that is shipped as part of NFS in the AIX Network Support Facilities of the Base Operating System (BOS) Runtime. In systems with AIX 4.3.1 or later, this is the AutoFS automounter. In previous levels of AIX, this is the Automount automounter. *IBM AIX Version 4 System Management Guide: Communications and Networks* describes the operation and use of this automounter and the format of the map files. In addition to the map file for the **/u** file system maintained by the SP system, you may provide your own automount map files to enable the **automount** daemon to control similar access to directories in other file systems that you would like to have automatically mounted on demand.

If you choose to install and use a different automounter, the SP system allows you to provide a set of user customization scripts that the system will use to replace its functions for configuring and starting the automounter daemon and managing the map file for the user home directory information. **amd_config** must still be set to `true`.

If your SP system contains nodes that are running PSSP 2.2 or previous releases, those nodes use Amd, the BSD automounter. The **amd_config** site environment variable specifies your choice for SP automounter configuration for all nodes, including these older nodes running Amd. The control workstation still maintains the Amd map file, in addition to the Automount map file, to support those nodes running Amd.

Automount Map Files

The AIX **automount** daemon reads automount map files to determine which directories to support. Typically, there is one map file for each file system to be controlled by the automounter. The map file contains entries for each directory supported within the file system, the host name where the directory resides, and the specific mount information for that directory. The automount map files are kept in the **/etc/auto/maps** directory, by default. The list of all map files to be used by the **automount** daemon is specified in the master map file **/etc/auto.master**. This master map file contains entries for each file system to be controlled by the automounter, the name of the map file containing the directory information, and optional default mount information.

If automounter support and the SP User Management interface are both configured for your site environment, **/u** is automatically controlled by the automounter. The SP-managed automount map file for the **/u** file system is **/etc/auto/maps/auto.u**. This map file contains a stanza for each user added using SP User Administration (either the **spmkuser** command or SMIT panels), containing the server name and directory location of the user's home directory. Existing users must be added to the map file using the **mkamdent** command.

An entry in the automount map file has the following format:

```
key -mount_options server_name:mount_directory:sub_directory
```

where:

key	The directory of interest within the file system
mount_options	Options used during the mount operation
server_name	The name of the machine that contains the directory
mount_directory	The exported directory from that machine
sub_directory	An optional sub-path under the exported directory

A special substitution value of & can be used to substitute the *key* value in the entry.

Note: An entry is added to **auto.u** for the net install ID's home directory. This **netinst** user ID is required by AIX for a net install.

Note for Users of AIX 4.3.0 or Earlier

The **automount** daemon will mount file systems in the **/tmp_mnt** directory using the following naming convention:

/tmp_mnt/*filesystem/first-accessed-sub_directory*

where *filesystem* is the name of the file system under automount control and *first-accessed-sub_directory* is the name of the first sub-directory accessed within a mounted directory. A symbolic link is made from the directory the user accessed to the appropriate sub-directory within that mount point:

/filesystem/sub_directory→**/tmp_mnt/***filesystem* \
first-accessed-sub-directory/sub_directory

where *sub_directory* is the name of the subpath currently being accessed by a user. This naming convention can be quite confusing because the physical directory path is dependent on some arbitrary name (that is, the first sub-directory accessed within a mounted directory). Because this name can change from one access period to another, you should not make any assumptions about this name or directly use it in any scripts or programs. Always access the directory through the automounter-supported path name. This naming convention may cause problems for C-shell users because the C-shell **pwd** built-in command returns the actual physical path and not the automounter-supported path, which is a symbolic link. The results of the C-shell command should not be stored for later use by the same program or another program or shared across a parallel execution environment; there is no guarantee the physical path name will exist.

Automount Daemon Example and AutoFS Example

The following examples illustrates how an automount map entry is used by the **automount** daemon and the **AutoFS** daemon to provide access to a user's home directory.

In the SP system, by default, the users' directories reside in **/home/***hostname*, where *hostname* is the short name for the host system. The following stanza shows the entry in the automount map **/etc/auto/maps/auto.u** for user **jws** whose home directory resides on **luna**:

```
jws luna:/home/luna:&
```

In this case, if a user is on **luna** and changes directories to **/u/jws**, automount will create a symbolic link to the local directory:

```
/u/jws→/home/luna/jws
```

AutoFS locally mounts the **/home/luna/jws** JFS directory at **/u/jws**. Issuing the **mount** command will show an entry similar to:

```
/home/luna/jws   /u/jws   jfs   Aug 07 09:07
```

However, if the user is on any machine other than **luna** and changes directories to **/u/jws**, automount mounts **luna:/home/luna** in the local **/tmp_mnt** directory at **/tmp_mnt/u/jws**. Automount then creates a symbolic link to the **jws** sub-directory under that mount point:

```
/u/jws→/tmp_mnt/u/jws/jws
```

AutoFS mounts the **luna:/home/luna/jws** NFS directory at **/u/jws**. Issuing the **mount** command will show an entry similar to:

```
luna   luna:/home/luna/jws   nfs   Aug 07  09:07
```

In the automount environment, because **jws** was the first user to access a sub-directory in **luna:/home/luna**, the **jws** sub-directory name appears twice in the physical path name. If a second user, **kcb**, also accesses a sub-directory in **luna:/home/luna**, automount creates the following symbolic link:

```
/u/kcb→/tmp_mnt/u/jws/kcb
```

In the automount environment, note the presence of **jws** in the physical path name. This is the name of the mount point the automounter used when mounting **luna:/home/luna**.

If a user's home directory resides in some other type of file system that already appears locally on the machine (for example, AFS), the server name should be specified as the local host. A map entry for a user with an AFS home directory would look like this:

```
tberry $HOST:/afs/kgn.ibm.com/usr2:&
```

In this case, when a user changes directories to **/u/tberry**, automount creates a symbolic link to the AFS directory:

```
/u/tberry→/afs/kgn.ibm.com/usr2/tberry
```

AutoFS mounts the **/afs/kgn.ibm.com/usr2/tberry** AFS directory at **/u/tberry**.

Note: The use of the *$HOST* substitution variable is specific to the SP invocation of the **automount** daemon. The AIX **automount** command allows you to specify substitution variables and values to be used in the map files. The SP invocation of the **automount** daemon includes the parameter **-D HOST**='*uname* **-n**' which sets *$HOST* to the name of the local machine as returned by the **uname** command.

See *IBM AIX 4 System Management Guide: Communications and Networks* for more information on the **automount**. daemon and map file format.

Automount Master Map Files

The SP invocation of the **automount** daemon uses the master map file **/etc/auto.master**. This master map file contains entries for each file system to be controlled by automount, the name of the map file containing the directory information, and optional default mount information. If you add additional file systems to be controlled by the **automount** daemon, you must edit this file and add an entry indicating the name of the file system and the full directory path of the associated map file. See “Using Automount for Other File Systems” on page 190.

If you wish to change the default mount options for mounting directories for the **/u** file system or any other file system controlled by the **automount** daemon, edit the **/etc/auto.master** file to add the mount options to the end of the appropriate file system entry. For example, to add mount options to the **/u** file system, your **/etc/auto.master** entry may be modified to appear as follows:

```
/u /etc/auto/maps/auto.u -rw,hard,retry=3,timeo=40,rsize=4096,wsize=4096
```

The master map file can also specify an NIS database as a map file. The Network Information Service (NIS) is a distributed database that allows you to maintain consistent configuration files throughout a network. By default, the SP invocation of the **automount** daemon turns off the use of the **auto.master** NIS database. If you are using NIS to maintain and distribute your automounter map files, you will need to edit the **/etc/auto.master** file to add as the first entry **+auto.master** which includes the NIS **auto.master** database.

See *IBM AIX 4 System Management Guide: Communications and Networks* for more information on the automount master map file format and on NIS.

File Collections and Automounter Files

If you have configured the SP to use file collections by setting the site environment variable **filecoll_config** to `true`, automount map files will be automatically distributed to all nodes. The automount map files are part of the **user.admin** file collection. The **/var/sysman/sup/user.admin/list** file contains entries to distribute the **/etc/auto.master** file, all files in the **/etc/auto/maps** directory, and all files in the **/etc/auto/cust** directory.

If you decide to replace some or all of the SP automounter function with your own, you might need to edit the **/var/sysman/sup/user.admin/list** file to distribute your own files or to remove the currently distributed SP files. In the list file, there exists a comment mentioning that SP automounter configuration has been added. Do **NOT** delete or change this comment. You may change or remove any other entries in the file as necessary for your automounter installation. However, if this comment is removed or altered on the control workstation, the next time your system is booted or the **services_config** command is run, the SP configuration will add the automount entries back again. See “Customizing the SP Automounter Function” on page 193 for more details on providing your own automounter customizations.

If you are not using file collections on your SP, you must use some other local means of distributing the automount map file, master map files, and user customization scripts to all of the nodes on your system. The SP will not copy your map files to the nodes for you.

See Chapter 7, “Managing File Collections” on page 137 for more information on the file collection processes.

Automounter Diagnostics

The SP automounter configuration and execution functions write error messages to an error log file, **/var/adm/SPlogs/auto/auto.log**. Also, the **automount** daemon uses the daemon facility of the BSD syslog subsystem to record errors. The control workstation and nodes have been configured to write all **daemon.notice** and greater messages to **/var/adm/SPlogs/SPdaemon.log**. If you are having problems with the automounter, you may need to stop the daemon, check the diagnostic information recorded in these logs, and restart the **automount** daemon. For more information on error logging, refer to Chapter 29, “Managing Error Logs” on page 431. You can find a description of the automounter error log, messages, and instructions for stopping and starting the **automount** daemon in *PSSP: Diagnosis Guide*.

Establishing an Automount Map for Users' Directories

If you have configured your SP to include both automounter and user management support, the SP will create and maintain an automount map file for users' home directories. When you add a new SP user to your system, a map entry will be added to **/etc/auto/maps/auto.u** associating the user's **/u** home directory with the actual physical directory located either on the current machine or on a remote file server that can be accessed through a network connection using NFS. This map entry will be changed or removed when SP User Management functions are used to change or remove the user from the system.

If you have existing users that do not have entries in the **auto.u** map file, you can use the **mkamdent** command to add home directory entries for them. The **mkamdent** command allows you to specify a list of users to add to the **auto.u** map. The command builds a stanza for each user in the list using the SP site environment values for **homedir_server** and **homedir_path** as the defaults (these can be set using SMIT panels, the Set Site Environment Information TaskGuide, or the **spsitenv** command). **homedir_server** is the default file server and **homedir_path** is the default base path for the home directory (not including the individual user's sub-directory). You can override these defaults with the **-s** flag. See *PSSP: Command and Technical Reference* for more information on the **mkamdent** and **spsitenv** commands.

You must make sure that the **/u** directory is not a symbolic link to some other directory. This will prevent the **automount** daemon from starting successfully. **/u** must exist as a local directory on each processor.

If you are not using SP User Management services, but would still like to have the **automount** daemon control access to directories in the **/u** file system, you can create and maintain your own **auto.u** map file. See “Using Automount for Other File Systems” on page 190 for details on how to add the map to the SP automounter support.

Changing User Home Directory Information

It may become necessary to change the user home directory information stored in the automounter map file. If, for example, the home directory is moved to a new server machine or to a different directory, the existing entry in the automounter map file will need to be updated with the new information. IBM suggests changing this information by using the **spchuser** command or the equivalent SMIT panels.

After updating the map file, you may need to wait up to 5 minutes with no access attempts to the user's home directory through the **/u** file system. This allows the automounter to time out any previous access attempts and unmount any existing mounts that may be referencing the old information. Do not attempt to force the unmount by manually issuing the **umount** command as that will put the automounter in an inconsistent state. You would then need to stop and restart the **automount** daemon to recover access to that user's home directory.

Using Automount for Other File Systems

If you have configured your SP with automounter support, you can use the **automount** daemon to provide automounting control for other file systems in your network. Each file system you want managed by automount requires an automount map file and an entry in the **/etc/auto.master** map file identifying the file system and its map file.

You must make sure the directory you are controlling with the **automount** daemon exists as a local directory on each processor and is not a symbolic link to another directory. Otherwise, the **automount** daemon will not start successfully.

The process to add additional file systems requires you to stop and start the **automount** daemon on all nodes. To do so, all activity with files and directories currently controlled by the **automount** daemon must be stopped. This includes all activity in users' home directories if the **automount** daemon is controlling the **/u** file system. You should plan to add all additional file systems to the automounter at a time when this would not adversely affect your system schedule or disrupt users.

The examples in this section illustrate the process for adding additional file systems and show how to provide automount support for automounting the **/vol** file system.

The steps in this process are:

1. Create an automount map file
2. Update the master map file
3. Add the map to the file collections
4. Distribute the map to the boot/install servers and nodes
5. Stop and restart the **automount** daemon

Step 1: Create an Automount Map File

The easiest way to create an automount map file is to copy an existing one and modify it for the new file system. The map can reside in any directory you like. The map for the **/u** file system is **/etc/auto/maps/auto.u**. It may be convenient for you to keep all of your automount map files in this **maps** directory.

Example

1. On the control workstation, copy the existing **auto.u** map and name it **auto.vol**, keeping it in the same directory. Enter:

   ```
   cp /etc/auto/maps/auto.u /etc/auto/maps/auto.vol
   ```

2. Replace the map entries with the directory and host information for **/vol** as shown here:

   ```
   inst.images  images1:/inst.images
   techlib      filesrv1:/share/&
   local        $HOST:/afs/site.edu/share/local
   ```

This example results in the following mounts for AIX 4.3.0 and earlier levels:

- If a user issues **cd /vol/inst.images**, **inst.images** is mounted from **images1** linking **/vol/inst.images→/tmp_mnt/vol/inst.images**

- If a user issues **cd /vol/techlib**, **/share/techlib** is mounted from **filesrv1** linking **/vol/techlib→/tmp_mnt/vol/techlib**
- If a user issues **cd /vol/local**, automount simply creates a symbolic link because the directory is accessible from the local host. The result is **/vol/local→/afs/site.edu/share/local**.

This example results in the following mounts for AutoFS systems:

- If a user issues **cd /vol/inst.images**, **inst.images** is mounted from **images1** at the local mount point **/vol/inst.images**
- If a user issues **cd /vol/techlib**, **/share/techlib** is mounted from **filesrv1** at the local mount point **/vol/techlib**
- If a user issues **cd /vol/local**, a local mount is made from **/afs/site.edue/share/local** to the mount point **/vol/local**.

Step 2: Update the Master Map File

Add an entry to the automount master map file **/etc/auto.master** so that when the **automount** daemon is restarted it will also control the file system being added. The entry may contain default mount options for all the directories listed in the automount map file.

Example

Add the following entry to **/etc/auto.master**:

```
/vol /etc/auto/maps/auto.vol -ro,soft,rsize=4096,wsize=4096
```

This will tell the **automount** daemon to use the **/etc/auto/maps/auto.vol** file when controlling access to directories within the **/vol** file system. The specified mount options will be used for each directory mount.

Step 3: Add the Map to the File Collections

If you are using file collections to distribute your map files, add the new map so that it can be distributed and managed by the file collection programs. If you have placed your map file in the **/etc/auto/maps** directory, you do not need to do anything for this step. The **user.admin** file collection already distributes all files in the **/etc/auto/maps** directory. However, if you have not placed your map file in the **/etc/auto/maps** directory, you will need to add the map to a file collection that is resident on all the systems you require. The **user.admin** collection is a good choice because it is resident on the control workstation, boot/install servers, and all processor nodes. See "SP File Collection Summary" on page 140 for a complete list of file collections provided by the SP.

Example

Add **auto.vol** to the **user.admin** file collection so that it can be distributed to all boot/install servers and nodes. To do this, edit the file collection list file **/var/sysman/sup/user.admin/list** and add the following entries to request an upgrade of this new map and to refresh the daemon after the upgrade:

```
upgrade ./etc/auto/maps/auto.vol
execute /etc/amd/refresh_amd (./etc/auto/maps/auto.vol)
```

Note: This step is not necessary for this example since the map file resides in the **/etc/auto/maps** directory and will already be automatically distributed. The details are provided here to illustrate how to update the file collection if the map file resides in some other directory.

Step 4: Distribute the Map to the Boot/Install Servers and Nodes

If you are using file collections to distribute your map files, check to see if you have a **scan** file for the file collection containing the new map.

Example

If you are using the **user.admin** file collection to distribute your map, check if the file **/var/sysman/sup/user.admin/scan** exists on the control workstation or any boot/install servers. If the **scan** file does exist, you will need to update it. On each processor that has a **scan** file for the collection, enter:

```
supper scan user.admin
```

You can wait for the scheduled **supper update** to update the file collection as specified in the **crontabs** file on each processor node. Or, if you want to distribute the map immediately, use a remote command to run the **supper update** command first on each boot/install server and then on each node.

Example

To distribute the **user.admin** file collection with the new map file immediately, run the following command first on each boot/install server and then on each node:

```
supper update user.admin
```

Step 5: Stop and Restart the automount Daemon

In order for the automounter to recognize the update to the **/etc/auto.master** file and handle the new file system, the automounter must be stopped and restarted. The daemon must be stopped at a time when no users are accessing files or directories under automount control. Plan this step for a time that is not disruptive to your users.

The cleanest and safest way to stop and restart the automounter is to reboot all the systems where this new map will reside.

If it is not possible to reboot the systems, then do the following to stop the **automount** daemon on AIX older systems:

1. Issue the **mount** command with no parameters to get the process ID of the **automount** daemon and to see if there are any active mounts on the **/tmp_mnt** directory. This is the directory the **automount** daemon uses as its mount point.
2. Stop all processes that are accessing files or directories controlled by the **automount** daemon.
3. Stop the **automount** daemon with the following command using the process ID returned by the mount command:

   ```
   kill -term process_id
   ```

   Note: It is important to issue the **kill -term** command (**kill -15**) and not **kill -kill** (**kill -9**) to allow the **automount** daemon to properly clean up its mounts and directories.

To stop AutoFS on systems with AIX 4.3.1 or later:

1. Issue the **mount** command with no parameters to see if there are any active mounts for automounter controlled directories.
2. Stop all processes that are accessing files or directories controlled by the automounter.
3. The automounter daemon is controlled by the System Resource Controller (SRC). Issue the following command to stop the AutoFS system:

   ```
   stopsrc –g autofs
   ```

Restart the **automount** daemon by running the following command:

```
/etc/auto/startauto
```

Customizing the SP Automounter Function

The SP automounter function has been implemented so that you can optionally replace some or all of the SP automounter function with your own customization scripts. By placing executable files in the **/etc/auto/cust** directory, you can provide your own automounter function that will be executed in place of the SP automounter function. This is useful if you need to do things such as change the map file entry format for entries in the **/u** map file **/etc/auto/maps/auto.u**, change the default options for invoking the **automount** daemon, or completely replace the SP use of the **automount** daemon with some other automounter that you provide.

In order to use these customization scripts, the SP automounter support must be configured for your system (the **amd_config** site environment variable is set to `true` using the **spsitenv** command, the Set Site Environment Information | TaskGuide, or SMIT panels). During the execution of the SP automounter function, | a check will be made to see if any of the following files exist and are executable. If so, that file will be invoked in place of the corresponding automounter function:

/etc/auto/cust/cfgauto.cust	Configure the automounter directories and create default files as necessary
/etc/auto/cust/startauto.cust	Start the automounter daemon
/etc/auto/cust/refauto.cust	Refresh the automounter daemon
/etc/auto/cust/checkauto.cust	Verify the automounter configuration and daemon execution
/etc/auto/cust/mkautoent.cust	Add an entry to the automounter map file for user home directories
/etc/auto/cust/rmautoent.cust	Remove an entry from the automounter map file for user home directories
/etc/auto/cust/lsautoent.cust	List an entry from the automounter map file for user home directories

Each file is independent and any or all files may exist. The SP automounter function will be replaced only for those functions which have an executable customization script. Details on how each of these files will be used by the SP is provided in the following sections.

If the automounter function is to be replaced on all boot/install servers and processor nodes, the customization scripts must be distributed. If you have file collections configured for your system, these files will automatically be distributed through the **user.admin** file collection. If you are not using file collections, you must distribute these files to the boot/install servers and processor nodes using some other means.

cfgauto.cust Customization Script

The **/etc/auto/cust/cfgauto.cust** file is an optional customization script that you may provide to configure the automounter directories and create default files. If this file exists, and it is executable, it will be invoked by the **services_config** installation command during the system boot process to configure your automounter installation. You should provide this file when you require a different automounter configuration than that provided by the SP. IBM suggests that your **cfgauto.cust** script create all directories and default files that are required by the automounter started by your **/etc/auto/cust/startauto.cust** script.

The **services_config** process will create the SP automounter log file as **/var/adm/SPlogs/auto/auto.log**. It will then check if **cfgauto.cust** exists and is executable, and if so, will invoke it. If not, the SP automounter configuration will be invoked using the **/usr/lpp/ssp/install/bin/cfgauto** installation script which creates the **/etc/auto** and **/etc/auto/maps** directories, and creates default **/etc/auto.master** master map and **/etc/auto/maps/auto.u** map files as necessary.

There are no input parameters passed to the **cfgauto.cust** script. The return value should indicate the following:

0	Success
non-0	A configuration problem occurred. In this case, the **services_config** process will not start the automounter daemon, but will continue with its other configuration functions.

Example

The following script is an example of a script you might use to configure directories and default files for a processor to use the Amd automounter instead of the AIX **automount** daemon:

```
#!/usr/bin/ksh

# Create /etc/amd directory
if [[ ! -a /etc/amd ]]; then
    mkdir /etc/amd
    if (($? != 0)); then
        echo "cfgauto.cust:  Cannot create directory /etc/amd."
      exit 1
    fi
fi

# Create /etc/amd/amd-maps dir
if [[ ! -a /etc/amd/amd-maps ]]; then
    mkdir /etc/amd/amd-maps
    if (($? != 0)); then
        echo "cfgauto.cust:  Cannot create directory /etc/amd/amd-maps."
       exit 1
    fi
fi
```

```
# Create default amd.u file with /defaults entry and an
# entry for the netinst userid
if [[ ! -a /etc/amd/amd-maps/amd.u ]]; then
    echo "/defaults rfs:=/homes/filesrv1;type:=nfs;sublink:=${key};
opts:=rw,hard,retry=3, timeo=40,rsize=4096,wsize=4096" >>
/etc/amd/amd-maps/amd.u
    if (($? != 0)); then
        echo "cfgauto.cust:  Cannot create default file
        /etc/amd/amd-maps/amd.u."
       exit 1
    fi
    echo "\nnetinst type:=link;fs:=/home" >> /etc/amd/amd-maps/amd.u
fi

# Set up /u so that Amd can handle mounts for amd.u map:
# No symbolic links allowed
if [[ -L /u ]]; then
    rm /u
    mkdir /u
fi
exit 0
```

startauto.cust Customization Script

The **/etc/auto/cust/startauto.cust** file is an optional customization script that you can provide to start your automounter daemon. If this file exists, and it is executable, it will be invoked by the **services_config** installation command during the system boot process to start your automounter daemon. You should provide this file when you require changes to the SP invocation of the **automount** daemon, or when you wish to replace it with the invocation of a different automounter daemon that you have made available on your system.

The **services_config** process will invoke the automounter configuration, and if that completes successfully, a check will be made to see if **startauto.cust** exists and is executable. If so, it will be invoked to start the automounter daemon. If not, the **automount** daemon will be started using **/etc/auto/startauto**.

There are no input parameters passed to the **startauto.cust** script. The return value has no affect on the **services_config** execution.

Example

The following script is an example of a user customization script that you might use to start the Amd daemon instead of the AIX **automount** daemon. This script assumes that you have Amd installed on your system and that the executables reside in the **/etc/amd** directory.

```
#!/usr/bin/ksh

# Check if Amd daemon is running
if [[ -n 'ps -ef | grep /etc/amd/amd | grep -v grep' ]]; then
    echo "startauto.cust:  amd daemon is already running."
    exit 0
fi

# Build amd input list using all amd.* map files in
# /etc/amd/amd-maps directory
set -A amdmaps $(ls /etc/amd/amd-maps/amd.*)
let i=0
while (( $i < ${#amdmaps[*]} )); do
  amd_parms="$amd_parms /${amdmaps[$i]##/*/amd.}
${amdmaps[$i]}"
  let i=$i+1
done

# Start the daemon
nice --4 /etc/amd/amd -t 16.120 -x all -l /var/adm/SPlogs/auto/auto.log
$amd_parms
exit $?
```

refauto.cust Customization Script

The **/etc/auto/cust/refauto.cust** file is an optional customization script that you can provide to refresh your automounter daemon. If this file exists, and it is executable, it will be invoked after a file collection update has been made to the **/etc/auto/maps/auto.u** map file for user home directories. You should provide this file when your automounter requires special refresh activity.

If you have file collections configured for your SP system, the **supper update** process on a boot/install server or processor node will update the **/etc/auto/maps/auto.u** map file when changes have been made. If this map file is updated, the automounter refresh is invoked. The refresh process will check to see if the **refauto.cust** customization script exists and is executable. If so, it will be invoked to refresh the automounter daemon. If not, no activity will occur since the **automount** daemon does not require refreshing.

If you are using file collections to distribute your map files and your automounter requires refreshing for updates to map files other than **/etc/auto/maps/auto.u**, you will need to update the list file for the collection. The **user.admin** collection is used to distribute all map files in the **/etc/auto/maps** directory. If you are also using **user.admin** to distribute your maps, you will need to edit the list file **/var/sysman/sup/user.admin/list** to contain an execute statement similar to the one for **auto.u**:

```
execute /etc/amd/refresh_amd (./etc/auto/maps/auto.u)
```

There are no input parameters passed to the **refauto.cust** script. The return value is noted by the **supper update** process.

Example

The following script is an example of a user customization script that you might use to refresh the Amd daemon. This script assumes that Amd is installed and that the executables reside in the **/etc/amd** directory.

```
#!/usr/bin/ksh

# If amd is running then refresh the maps with amq -f
if [[ -n 'ps -ef | grep /etc/amd/amd | egrep -v grep' ]]; then
  /etc/amd/amq -f
fi
```

checkauto.cust Customization Script

The **/etc/auto/cust/checkauto.cust** file is an optional customization script that you can provide to verify your automounter installation. If this file exists, and it is executable, it will be invoked from the **SYSMAN_test** command to verify your automounter installation. You should provide this file when you have provided your own automounter configuration using **/etc/auto/cust/cfgauto.cust** or started your own automounter daemon with **/etc/auto/cust/startauto.cust**. IBM suggests that your **checkauto.cust** checks all files and directories required by your automounter and that your automounter daemon is running.

The **SYSMAN_test** process will check if **/etc/auto/cust/checkauto.cust** exists and is executable. If so, it will invoke it. If not, it will invoke the SP automounter verification. This code checks that all required SP automounter directories and files exist and that the SP automounter daemon is running.

The **checkauto.cust** script will be invoked with the same syntax as the **SYSMAN_test** command:

```
checkauto.cust [-q | -v] -l log_file
```

The parameters are those supplied to the **SYSMAN_test** command with the following definitions:

-q	Specifies quiet mode; error messages are only appended to the log file and not written to stdout.
-v	Specifies verbose mode; all error and informational messages are written to both the log file and stdout.
-l *logfile*	Specifies the path name of the log file to which messages are appended.

If neither **-q** nor **-v** are specified, error messages are written to both the log file and stdout.

The return value from **checkauto.cust** execution should be:

0	Indicates success
non-0	Indicates the number of verification errors that were found

Example

The following script is an example of a user customization script that you might use to verify your Amd configuration and daemon execution. This script assumes that Amd is installed and that the executables reside in the **/etc/amd** directory.

```
#!/usr/bin/ksh

while getopts “qvl:” opt; do
  case $opt in
      q ) QUIET=“-q” ;;
      v ) VERBOSE=“-v” ;;
      l ) LOGFILE=$OPTARG ;;
  esac
done

let ERRORS=0
# Check for /etc/amd directory
if [[ ! -a /etc/amd ]]; then
    if [[ -z $QUIET ]]; then
        echo “checkauto.cust:  Directory /etc/amd does not exist.”
    fi
    echo “checkauto.cust:  Directory /etc/amd does not exist.” >> $LOGFILE
    let ERRORS=$ERRORS+1
fi

# Check for /etc/amd/amd-maps dir
if [[ ! -a /etc/amd/amd-maps ]]; then
    if [[ -z $QUIET ]]; then
        echo “checkauto.cust:  Directory /etc/amd/amd-maps does not exist.”
    fi
    echo “checkauto.cust:  Directory /etc/amd/amd-maps does not exist.” >> $LOGFILE
    let ERRORS=$ERRORS+1
fi

# Check for default amd.u file
if [[ ! -a /etc/amd/amd-maps/amd.u ]]; then
   if [[ -z $QUIET ]]; then
       echo “checkauto.cust:  Map file /etc/amd/amd-maps/amd.u does not exist.”
   fi
   echo “checkauto.cust: Map file /etc/amd/amd-maps/amd.u does not exist.” >> $LOGFILE
   let ERRORS=$ERRORS+1
fi

# Check if /u is a symbolic link
if [[ -L /u ]]; then
    if [[ -z $QUIET ]]; then
       echo “checkauto.cust:  /u is a symbolic link.  Not allowed by Amd.”
    fi
    echo “checkauto.cust:  /u is a symbolic link.  Not allowed by Amd.” >> $LOGFILE
    let ERRORS=$ERRORS+1
fi

# Check if Amd daemon is running
if [[ -z 'ps -ef | grep amd | grep -v grep' ]]; then
    if [[ -z $QUIET ]]; then
        echo “checkauto.cust:  amd daemon is not running.”
    fi
    echo “checkauto.cust:  amd daemon is not running.” >> $LOGFILE
    let ERRORS=$ERRORS+1
fi

exit $ERRORS
```

mkautoent.cust Customization Script

The **/etc/auto/cust/mkautoent.cust** file is an optional customization script that you can provide to add a user home directory entry to your automounter map file. If this file exists, and it is executable, it will be invoked by the SP User Management commands **spmkuser**, **spchuser**, and **mkamdent** either directly or through SMIT panels. You should provide this file when you require a different map file or map file format than that generated by the SP User Management services for the **/etc/auto/maps/auto.u** map file. If you do provide this file, you will probably also need to provide **/etc/auto/cust/rmautoent.cust** and **/etc/auto/cust/lsautoent.cust**. These files remove and list the user's home directory entry in the map file.

When SP User Management services process user home directory additions or updates, a check is made to see if **mkautoent.cust** exists and is executable. If so, it will be invoked to process the home directory information for your automounter map file. If not, the automount map file **/etc/auto/maps/auto.u** will be updated with the new home directory entry.

The Parallel Operating Environment (POE) component in the AIX Parallel Environment contains the command **mpamddir** which is dependent on the format of the SP supported automount map file. If you have this support installed on your system and are using the command, you may need to provide an additional user exit. See *IBM Parallel Environment for AIX: Operation and Use* for more information.

The **mkautoent.cust** script is invoked with the following syntax:

```
mkautoent.cust user host[,host...] pathname
```

The parameters have the following definitions:

user	The user name that is to be used as a key to the new map entry.
host[,host...]	One or more host names separated by commas indicating the target host where the user's home directory resides.
pathname	Directory path name of the user's home directory as it is defined on the host. The trailing user subdirectory has been removed from the path name.

For example, the syntax for a user **jws** with a home directory on **luna** with the path name of **/home/luna/jws** would be:

```
mkautoent.cust jws luna /home/luna
```

The return value from **mkautoent.cust** execution should indicate:

0 Success

non-0 An error occurred creating the map file entry. The following actions will occur:

- The **mkamdent** command will return this value as its return code.
- The **spmkuser** command creates the user before invoking this script, so the return code has no affect on the command. The user is still added.
- The **spchuser** command will terminate and not change the user information.

Example

The following script is an example of a user customization script that you might use to add an entry to your **/etc/amd/amd-maps/amd.u** map file.

```
#!/bin/ksh

# get input parms
USER=$1
HOSTS=$2
HOMEPATH=$3
AMDMAP=/etc/amd/amd-maps/amd.u
HOSTS='echo $HOSTS | sed 's/,/ /g''

# Append the entry to the amd /u map
FIRST=“ ”
for HOST in $HOSTS; do
  if [[ -z $FIRST ]]; then
    echo “$USER  host==$HOST;type:=link;fs:=$HOMEPATH \\” >> $AMDMAP
    FIRST=$HOST
  else
    echo “host==$HOST;type:=link;fs:=$HOMEPATH \\” >> $AMDMAP
  fi
done
echo “host!=$FIRST;type:=nfs;rhost:=$FIRST;rfs:=$HOMEPATH” >> $AMDMAP
```

rmautoent.cust Customization Script

The **/etc/auto/cust/rmautoent.cust** file is an optional customization script that you can provide to remove a user home directory entry from your automounter map file. If this file exists, and it is executable, it will be invoked by the SP User Management commands **sprmuser** and **spchuser** either directly or through SMIT panels. You should provide this file when you have provided **/etc/auto/cust/mkautoent.cust** support for a different map file or map file format than that generated by the SP User Management services for the **/etc/auto/maps/auto.u** map file.

When SP User Management services process user home directory removals, a check is made to see if **rmautoent.cust** exists and is executable. If so, it will be invoked to remove the home directory information from your automounter map file. If not, the entry will be removed from the automount map file **/etc/auto/maps/auto.u**.

The **rmautoent.cust** script will be invoked with the following syntax:

```
rmautoent.cust user
```

The parameters have the following definitions:

user	The user name that is used as the key of the map entry to be removed.

For example, the syntax for a user **jws** with a home directory on **luna** with the path name of **/home/luna/jws** would be:

```
rmautoent.cust jws
```

The return value from **rmautoent.cust** execution should indicate:

0	Success

non-0 An error occurred removing the map file entry. The following actions will occur:

- The **sprmuser** command removes the user before invoking this script, so the return code has no affect on the command. The user will still be removed.
- The **spchuser** command will terminate and not change the user information

Example

The following script is an example of a user customization script that you might use to remove an entry from your **/etc/amd/amd-maps/amd.u** map file.

```
#!/bin/ksh

# Get input parms
USER=$1
AMDMAP=/etc/amd/amd-maps/amd.u

# Delete the entry to the amd /u map
sed -e"/^$USER /,/[^\\]$/d" $AMDMAP > $AMDMAP.tmp
mv $AMDMAP.tmp $AMDMAP
exit 0
```

lsautoent.cust Customization Script

The **/etc/auto/cust/lsautoent.cust** file is an optional customization script that you can provide to list a user's home directory information stored in your automounter map file. If this file exists, and it is executable, it will be invoked by the SP User Management command **splsuser** either directly or through SMIT panels. You should provide this file when you have provided **/etc/auto/cust/mkautoent.cust** support for a different map file or map file format than that generated by the SP User Management services for the **/etc/auto/maps/auto.u** map file.

The **splsuser** command checks to see if **lsautoent.cust** exists and is executable. If so, it will be invoked to list the home directory information from your automounter map file. If not, the information stored in the automount map file **/etc/auto/maps/auto.u** will be listed.

The **lsautoent.cust** script will be invoked with the following syntax:

```
lsautoent.cust user
```

The parameter has the following definition:

user The user name that is used as the key of the map entry containing the home directory information to be returned.

The user home directory information should be echoed to stdout in the following format:

```
host[,host...]
pathname
```

where:

host[,host...] Lists one or more host names separated by commas indicating the target host where the user's home directory resides.

pathname	Lists the directory path name of the user's home directory as it was provided to the **mkautoent.cust** script with the trailing *user* subdirectory removed from the path name.

For example, the syntax for a user **jws** with a home directory on **luna** with the path name of **/home/luna/jws** would be:

```
lsautoent.cust jws
```

and the return value written to stdout would be:

```
luna /home/luna
```

The return value from **lsautoent.cust** execution should indicate:

0	Success
non-0	An error occurred listing the map file entry. The **splsuser** command will list default user home directory information if the output from this script is null.

Example

The following script is an example of a user customization script that you might use to remove an entry from your **/etc/amd/amd-maps/amd.u** map file.

```
#!/bin/ksh
# Get input parms
USER=$1
AMDMAP=/etc/amd/amd-maps/amd.u

# Find the entry in the amd /u map and return the host and directory
hosts='cat $AMDMAP | sed "
/^$USER /,/[^\\]$/!d
/host==/!d
s/.*host==\(.[^; ]*\).*$/\1/g"'
hosts='echo $hosts | sed "s/\([^ ]*\)[ ][ ]*\(.[^ ]*\)/\1,
\2/"g'
home_dir='cat $AMDMAP | sed "
/^$USER /,/[^\\]$/!d
/rfs:=/!d
s/.*rfs:=\([^; ]*\)[^ ]*/\1/g"'

echo $hosts $home_dir

exit 0
```

Chapter 11. Managing Mail Service

The Mail Services provided on the SP are the same as the ones provided on a standard AIX environment. From the mail service point of view, the SP can be viewed as any other cluster of nodes. If you need to provide mail access on the nodes, the same configuration rules and techniques used for the rest of the LAN or intranet apply. Since this topic is not SP specific, but rather AIX specific, see the following documents for additional information:

- From the Internet
  - AIX Installation Guides at Web site:
    http://www.rs6000.ibm.com/doc_link/en_US/a_doc_lib/aixuser/usrcomm/toc.htm

    Search for the *mail overview* chapter.
  - AIX System Management Guides at Web site:
    http://www.rs6000.ibm.com/doc_link/en_US/a_doc_lib/aixbman/commadmn/toc.htm

    Search for *mail* in the table of contents.
- From the Redbook Libraries
  - The Next Step in Messaging: Upgrade Case Studies for Lotus cc:Mail to Lotus Domino and Lotus Notes
- From the Administration Guides
  - AIX Version 4.3 System Users' Guide: Communications and Networks

Besides the IBM publications on the subject, several other books discuss all pertinent subjects like SMTP, UUCP, TCP/IP, POP, IMAP, DNS, NFS, NIS, and even configuring popular E-mail software packages.

Chapter 12. Accounting

Your hardware resources are likely to be distributed unevenly across your SP System, with some nodes equipped for greater processing capacity and I/O than others. For this reason you may want to charge different usage fees for different nodes. You may also want to consolidate all accounting records, for the entire SP system, or for groups of nodes.

One way to make efficient use of the nodes in your SP system is to logically partition them so that each pool supports a different type of workload and is considered a separate management domain. The pooling of nodes according to configuration or workload type is the concept behind the *accounting class*. SP accounting allows you to logically group SP nodes with similar operating characteristics into an accounting class for which the same charge fee applies.

You may also want to charge a different usage fee for compute-intensive jobs when they demand exclusive use of one or more nodes. SP System accounting provides a mechanism for treating these jobs separately as well.

| **Usage note:**

| To run the commands specified in this chapter, you must be logged in as the
| root user with write access to the SDR.

Accounting by Node or by Class

An accounting class is a group of nodes for which accounting data is merged together, providing a single report for the nodes in that class. Individual nodes within a class may be enabled or disabled for accounting.

The **acct_class_id**, an attribute of each node object in the System Data Repository, is an arbitrary string you define and specify for all nodes for which you wish to group and merge accounting data.

Default values eliminate the need to define each attribute for each node. The default value of **acct_class_id** for each node is **default**. Therefore, all nodes initially belong to one accounting class called **default**.

The initial value of the **acct_enable** attribute for each node is also **default**. All nodes with **acct_enable=default** are enabled or disabled for accounting based on a system-wide accounting enabled attribute (**spacct_enable**) you define for your site environment. When you set **spacct_enable** to **true**, it enables accounting on all nodes for which the individual accounting enabled attribute (**acct_enable**) is set to **default**. Likewise, when you set **spacct_enable** to **false** (the initial value at installation), accounting is disabled on all nodes that have **acct_enable=default**. Thus, accounting can be enabled or disabled for the entire SP system with individual nodes treated as exceptions.

How SP Accounting Differs from Standard AIX

Standard AIX accounting uses a script called **runacct**. This script is normally run every night by **cron** to provide daily usage reports. It also keeps a running total of usage over some fiscal period (usually a month). SP accounting splits the **runacct** function into two parts. The first part is a script that is run on each SP node every night, just as **runacct** does. This script is named **nrunacct**. The second part is a script that executes on an **accounting_master** node each night, after the **nrunacct** scripts are run. This script is named **crunacct** and it consolidates the **nrunacct** information from each node. The scripts **cmonacct** and **cprdaily** are SP versions of standard AIX programs, modified to handle accounting class and exclusive use accounting.

nrunacct

The **nrunacct** script provides the function that merges raw data from the process, login, print, fee and disk subsystems. It also provides support to account for the exclusive use of a node.

nrunacct also creates an SP version of the **loginlog** file using the **var/adm/acct/sum/loginlog** files for the specified accounting cycle. Only the most recent **loginlog***yyyymmdd* file from each node is pertinent.

nrunacct provides a user exit for any site-specific accounting procedures in the **/var/adm/nsiteacct** file.

crunacct

The **crunacct** script provides the function that produces daily summary reports and accumulates data for the fiscal period, using the merged data from each node.

SP accounting merges total accounting data by user ID and login name, just as the standard AIX accounting does. This means that all SP nodes must have identical user IDs and login names. In other words, all SP nodes must be members of the same user name space, whether it is implemented through NIS, the SP User Management tools, or through other means.

cmonacct

An SP version of **monacct**, **cmonacct** creates summary files for monthly or fiscal reports.

cprdaily

An SP version of **prdaily**, **cprdaily** creates daily report files of accounting activity and cleans up files no longer needed.

Accounting for Exclusive Use of Node Jobs

While SP nodes are expected to execute exclusive parallel jobs, nonexclusive parallel jobs, and nonparallel jobs during a single accounting cycle, normal operation often results in the exclusive use of a node when executing a compute-intensive parallel job. A single job that makes such great demands on the compute resources of a node where no other jobs can share that node's resources is said to be an *exclusive use of a node* job. Such jobs can be handled separately for accounting purposes.

Standard AIX accounting produces a record for each process as the process completes. These records are later merged by user ID and login name. A user who executes one or more types of jobs on the same node has all process accounting records for that node merged together, resulting in the loss of those processes that had exclusive use of the node. It is important to track the exclusive use of a node by a user because the cost is likely to be different than the cost of shared use.

SP accounting addresses exclusive-use jobs as follows: Before starting a job that has exclusive use of a node, LoadLeveler executes a start job command under the real user ID of the job. When the job is finished LoadLeveler executes an end job command, again under the real user ID of the job. These commands consist solely of an **exit()** system call in their **main()** procedure. Their purpose is to generate process accounting records for the user ID of the job that can then be used to *bracket* all of the normal process accounting records of the job. In other words, all of the process accounting records generated by an exclusive job can be identified and excluded from the other process accounting records generated on the node.[3]

The process accounting records for the start job and end job programs are used to calculate the time the job had exclusive use of the node. The time is then charged to the user ID of the job by converting it to charge fee units. Use of the charge fee mechanism eliminates the need to generate additional accounting reports.

Accounting records for the start job and end job programs are identified by the names of the commands as found in the records. These start and stop programs are given the nonstandard names of **SJSJSJSJ** and **EJEJEJEJ** to avoid conflict with any other standard job names.

An attribute of the SP object in the SDR, **spacct_excluse_enable**, determines whether the start job program and end job program are executed for exclusive-use jobs. A node-level SDR attribute, **acct_excluse_enable**, determines whether accounting is activated to process start and end job records, and to generate charge fee records for jobs making exclusive use of that node.

Setting Up SP Accounting

IBM General Concepts and Procedures for RS/6000, describes a procedure for setting up an accounting system that involves performing the following steps for each AIX system:

- Creating directories
- Creating and updating files
- Enabling accounting
- Adding accounting procedures to **crontabs**

In a parallel environment, where there may be hundreds of nodes, it is essential that these tasks be automated. The SP TaskGuide called Set Site Environment Information helps with some automation.

Aside from the TaskGuide, the following accounting and system partitioning procedure helps you to tailor your accounting system by defining accounting class identifiers and accounting enabled attributes on an SP system level or on an individual node basis, if necessary. Accounting class identifiers need only be specified when you want more than one accounting class. You can also specify

[3] The Resource Manager function has been integrated into the IBM LoadLeveler product.

which nodes are to have accounting enabled, however, if all nodes are to be enabled, then only SP Accounting Enabled need be set to `true` and the **acct_enable** attribute can be left to default on each Node object in the SDR.

In addition, this procedure shows you how to specify exclusive use accounting, and how to specify an Accounting Master other than the default control workstation. It also shows how to set an SP Accounting Active Node Threshold value other than the default value of 80.

| You can define or change these values after installation by using SMIT, the Set
| Site Environment Information TaskGuide, or the **spacctnd** and **spsitenv** commands.

Accounting and System Partitioning

If you do not partition your SP system or if you run with a single system partition, you can assign any node or the control workstation as the accounting master.

Step 1: Enter System Accounting Information

Use SMIT or the **spacctnd** and **spsitenv** commands to define how accounting is to be done on your SP System. This information is read by the installation scripts, which enter specific details about your site's configuration into the System Data Repository (SDR).

Note

As of PSSP 3.1, the Resource Manager function has been integrated into the IBM LoadLeveler product.

If you are setting up accounting and modifying Node objects in the SDR on an SP system that is already running LoadLeveler, you need to update the **spacct_excluse_enable** keyword on the relevant machine stanzas and reconfigure LoadLeveler.

If you are only changing the SP object in the SDR on an SP system that is already running Resource Manager (to enable exclusive use accounting, for example), then you must reconfigure the Resource Manager using the **jm_config** command.

Using SMIT

TYPE **smit enter_data**

- The Enter Database Information Window appears.

SELECT Site Environment Information

- The Site Environment Information menu appears.

TYPE The data in the fields, as needed.

Using spsitenv

The following example enables accounting as the default for all nodes and specifies `2` as the accounting master. It also enables exclusive use accounting.

```
spsitenv acct_master=2 spacct_enable=true spacct_excluse_enable=true
```

Accounting information on the smit enter_data panel includes:

SP Accounting Enabled
: Use this field to specify whether by default, accounting is enabled or disabled on all nodes that have an accounting enabled attribute of **default**. A value of **true** indicates that accounting is enabled on all nodes with an accounting enabled attribute of **default**. A value of **false** indicates that accounting is disabled on all nodes that have an accounting enabled attribute of **default**. The initial value for this attribute is **false**.

  This sets the **spacct_enable** attribute in the SP object of the SDR. You can specify this attribute by using the **spsitenv** command instead of SMIT.

SP Accounting Active Node Threshold
: Use this field to specify the minimum percentage of nodes for which accounting data must be present. At the time when the new **crunacct** script runs, data must be available from at least this percentage of nodes in order for processing to continue. The default value for this attribute is **80**.

  This sets the **spacct_actnode_thresh** attribute in the SP object of the SDR. You can specify this attribute when using the **spsitenv** command instead of SMIT.

SP Exclusive Use Accounting Enabled
: Use this field to specify whether to activate start and end job records, and thus charge fee records for jobs requesting the exclusive use of a node. The default value for this attribute is **false**.

  This field sets the **spacct_excluse_enable** attribute in the SP object of the SDR. You can specify this attribute when using the **spsitenv** command instead of SMIT.

  A value of **true** specifies that exclusive use accounting is enabled on all nodes where the **acct_excluse_enable** attribute is set to `true`. You must check each node's **acct_excluse_enable** attribute for account processing. A value of **false** (the default) specifies that exclusive use accounting is disabled on the node.

Accounting Master
: Use this field to specify which node is to act as the accounting master. This is the node that executes **crunacct**. The default value for this attribute is **0** (the control workstation) but you can specify any SP node.

  This sets the **acct_master** attribute in the SP object of the SDR. You can specify this attribute when using the **spsitenv** command instead of SMIT.

Step 2: Enter Node Accounting Information

Use SMIT or the **spacctnd** command to further define SP accounting at the node level.

Using SMIT

TYPE **smit node_data**

- The Node Database Information menu appears.

SELECT Accounting Information

- The Accounting Information menu appears.

TYPE The data in the fields, as needed.

Accounting information on this panel includes:

Start Frame
: Enter the frame number that corresponds to the nodes required for this operation. Specify a value between 1 and 128 inclusive.

Start Slot
: Enter the slot number of first node to be used for this operation. Specify a value between 1 and 16 inclusive. Remember that a wide node counts as two slots.

Number of Nodes
: Number of nodes to be used for this operation. The node information is added for successive nodes within a frame. If the count of nodes causes the nodes in a frame to be exhausted the operation continues in the next sequential frame. Specify a value between 1 and 1024 inclusive.

Accounting Class Identifier
: Use this field to change the accounting class. All nodes with the same string value constitute a class for purposes of grouping and merging accounting data. All nodes will have an initial accounting class identifier of **default**.

  This sets the **acct_class_id** attribute in the Node object of the SDR. You can specify this attribute when using the **spacctnd** command instead of SMIT.

  You only need to specify a value for this field when you want to change the accounting class.

Accounting Enabled
: Use this field to indicate whether accounting is enabled or disabled for a node. A value of **true** indicates that accounting is enabled for the node. A value of **false** indicates that accounting is disabled for the node. All nodes have an initial value of **default** assigned to this attribute. A value of **default** indicates that the node is enabled for accounting based on your entry in the SP Accounting Enabled field in the SMIT Site Environment panel in Step 1.

  This sets the **acct_enable** attribute in the Node object of the SDR. You can specify this attribute when using the **spacctnd** command instead of SMIT.

Exclusive Use Accounting Enabled

Use this type field to indicate whether accounting start and end job records, and charge fee records, are processed for jobs having exclusive use of the node. A value of **true** indicates that exclusive use accounting is enabled and start and end job records will be generated. A value of **false** indicates that exclusive use accounting is not enabled and start and end job records will not be generated. All nodes have an initial value of **false** assigned to this attribute.

This sets the **acct_excluse_enable** attribute in the Node object of the SDR. You can specify this attribute when using the **spacctnd** command instead of SMIT.

Accounting Job Charge Value

This value is used to determine the number of charge fee units to charge a user for exclusive use of the node and its value is in units of *seconds per charge fee unit*. All nodes have an initial value of **1.0** assigned to this attribute.

This sets the **acct_job_charge** attribute in the Node object of the SDR. You can specify this attribute when using the **spacctnd** command instead of SMIT.

Using spacctnd

The following example adds accounting information for a system with one frame and 16 nodes. Accounting and exclusive use accounting is to be enabled for each node and 60 seconds of exclusive use by a user is to constitute one charge fee unit.

```
spacctnd -e true -j 60.0 -x true 1 1 16
```

Additional Accounting Setup Tasks

Depending on your environment, you may also wish to perform these tasks:

- Defining the file systems for which disk accounting is to be done.
- Defining the print queues for which printer accounting is to be done.
- Defining how the all print jobs owned by the print manager id (**prtid**) in Secure Mode are to be handled for accounting purposes.
- Disk accounting may be enabled for each file system as it is created. Alternatively, if many file systems already exist, then disk accounting may be turned on or off by executing the **chfs -t'yes'** <**filesystem>** command on the nodes.

Accounting Installation

The accounting installation phase is performed automatically when you select the Accounting Support option in **ssp.sysman** during the **installp** process. (Refer to the *PSSP: Installation and Migration Guide* .) This accounting installation process is also performed when you update accounting using **spsitenv**.

The accounting installation process:

1. Creates all necessary directories and files on the nodes for which accounting is enabled and on the **acct_master** node.

2. Adds the **startup** command to the **/etc/rc** file on the nodes for which accounting is enabled.
3. Creates the **/var/adm/acct/nite/jobcharge** file on each node for which accounting is enabled. This file contains the job charge value previously defined for the node.
4. The **holidays** file (**/etc/acct/holidays**) is placed in the **user.admin** file collection and is available on all nodes. Its source is the control workstation. If you do not use file collections, propagate this file, using whatever means is available in your environment, to all nodes in the SP System.

   Note: You may have to update the **holidays** file to reflect the correct information for the current year.
5. Update the **crontabs** file to schedule the accounting processes. See "Accounting Template for crontabs."
6. Initialize the login and process account data files. Enter:

   ```
   /usr/sbin/acct/nulladm /var/adm/wtmp /var/adm/pacct
   ```

Accounting Template for crontabs

A default **crontab** template file, describing when each accounting command should be run, is shipped as **/usr/lpp/ssp/config/cron_template** and distributed via a file collection. If you wish to run your accounting system on a different schedule, make the appropriate changes to this template. When booting, each node for which accounting is enabled, ensures that its **crontab** file is updated using this template. If the template does not exist, it is assumed that you use file collections to distribute **crontab** and nothing is done.

The **crontab** template file, shown below, contains a partial **crontab** entry. Each line begins with a keyword specifying a command used by the accounting process.

```
# This is the crontab template file. It is read by acct_config
# to update the root crontab file with accounting-related entries.

DODISK   0 1 * * 4
CHKPACCT 5 * * * *
NRUNACCT 0 2 * * 1-6
CRUNACCT 0 4 * * 1-6
CMONACCT 15 5 1 * *
```

Figure 8. Accounting Template for crontabs

DODISK and **CHKPACCT** are standard **crontab** keywords. **NRUNACCT**, **CRUNACCT**, and **CMONACCT** are variations of standard AIX accounting commands discussed earlier in this section. Refer to Chapter 13, "Maintaining the crontabs File" on page 217 for more information on **crontabs**.

Accounting Files

All accounting data, report, and summary files reside in the **/var/adm** directory. The accounting data files belong to members of the *adm* group, and all active data files (such as **wtmp** and **pacct**) reside in the adm home directory, **/var/adm**.

Note

The System Administrator should monitor the capacity of the **/var** file system when exclusive use accounting is enabled because large **/var/adm/pacct** files may be created and accounting will save the **excl_Spacct** files in the **/var/adm/acct/nite** directory. This may require the administrator to periodically increase the **/var** file system size or remove unnecessary **excl_Spacct** files. The System Administrator may edit the **/usr/lpp/ssp/bin/nrunacct** script in the CLEANUP section to automatically remove **excl_SPacct** files.

Data Files

Data files are:

/var/adm/acct/nite/dacct
Contains disk total accounting records, created by the **dodisk** command.

/var/adm/fee
Contains output from the **chargefee** command, in ASCII **tacct** records.

/var/adm/pacct
Active process accounting file.

/var/adm/wtmp
Active login accounting file.

/var/adm/Spacct*i.yyyymmdd*
Contains process accounting files for *yyyymmdd* during the execution of the **nrunacct** command.

Report and Summary Files

Report and summary files reside in the **/var/adm/acct** subdirectory. You must create the following subdirectories before the accounting system is enabled.

/var/adm/acct/nite
Contains files that **nrunacct** and **crunacct** command use in daily accounting.

/var/adm/acct/sum
Contains the cumulative summary files that **nrunacct** and **crunacct** update daily.

/var/adm/cacct
Contains files that the **crunacct** command uses in daily accounting.

nrunacct Command Files

The following report and summary files, produced by the **nrunacct** command, are of particular interest.

/var/adm/nsiteacct
Contains site-specific accounting procedures for node accounting.

/var/adm/acct/nite/lineuse*yyyymmdd*
Contains usage statistics for each terminal line on the system. This report is especially useful for detecting bad lines. If the ratio between the number of logouts and logins exceeds 3 to 1, it is possible that a line is failing.

/var/adm/acct/nite/daytacct*yyyymmdd*
Total accounting file for the previous day.

/var/adm/acct/sum/daycms*yyyymmdd*
Contains the daily command summary.

/var/adm/acct/sum/loginlog*yyyymmdd*
Contains a record of the last time each user ID was used.

/var/adm/acct/nite/reboots*yyyymmdd*
Contains beginning and ending dates from the **wtmp** file and a listing of system restarts.

crunacct Command Files

/var/adm/csiteacct
Contains site-specific accounting procedures for cluster accounting.

These files are copied to the **acct_master** node during **crunacct** execution.

/var/adm/cacct/*node***/nite/lineuse***yyyymmdd*
/var/adm/cacct/*node***/nite/daytacct***yyyymmdd*
/var/adm/cacct/*node***/nite/reboots***yyyymmdd*
/var/adm/cacct/*node***/sum/daycms***yyyymmdd*
/var/adm/cacct/*node***/sum/loginlog***yyyymmdd*

The *node* level files are merged to become:

/var/adm/cacct/sum/*class***/tacct***yyyymmdd*.
/var/adm/cacct/sum/*class***/daycms***yyyymmdd*.

which in turn update cumulative summary files:
/var/adm/cacct/sum/*class***/tacct** file..
/var/adm/cacct/sum/*class***/cms** file..

Files in the /var/adm/acct/nite Directory

active
Used by the **nrunacct** command to record progress and to print warning and error messages. The file **active.***yyyymmdd* is a copy of the active file made by **nrunacct** after it detects an error.

jobcharge
Contains a floating point number used to determine the number of charge fee units to charge a user for exclusive use of the node and its value is in units of *seconds per charge fee unit*.

jobrecs
Contains *start job* and *end job* records used for accounting on jobs that make exclusive use of nodes.

ptacct.*yyyymmdd*
Contains summary version of **pacct** files.

ctmp
Contains connect session records during **nrunacct**

accterr
Contains standard error messages produced during the execution of the **nrunacct** command.

lastdate
: Indicates the last day the **nrunacct** command executed, in **yyyymmdd** format.

lock
: Used to control serial use of the **nrunacct** command.

statefile*yyyymmdd*
: Used to record the current state during execution of the **nrunacct** command.

wtmperror
: Contains **wtmpfix** error messages.

owtmp.
: Contains the previous day's **wtmp** file.

Files in the /var/adm/cacct/ Directory

active
: Used by the **crunacct** command to record progress and to print warning and error messages. The file **active.***yyyymmdd* is a copy of the active file made by **crunacct** after it detects an error.

lastdate
: Indicates the last day the **crunacct** command executed, in **yyyymmdd** format.

lock
: Used to control serial use of the **crunacct** command.

statefile*yyyymmdd*
: Used to record the current state during execution of the **crunacct** command.

lastcycle
: Indicates the date of the last successfully completed **crunacct** cycle.

fiscal_periods
: Defines the start date of each fiscal period.

Files in the /var/adm/cacct/sum Directory

<**class>/cms**
: Daily command summary.

loginlog
: File listing current login records.

rprt*yyyymmdd*
: Saved output of the **cprdaily** routine executed in **crunacct**.

<**class>/tacct**
: Process account summaries.

Files in the /var/adm/cacct/fiscal Directory

/var/adm/cacct/fiscal/*class***/cms***mm*
Total class summary file for the month, in binary format.

/var/adm/cacct/fiscal/*class***/tacct***mm*
Total accounting file for month, in binary format.

/var/adm/cacct/fiscal/fiscrpt*mm*
Report similar to that of the **prdaily** command for month, in binary format.

Chapter 13. Maintaining the crontabs File

The SP system uses the **crontabs** file to periodically update file collections and clean up log files. The installation process appends entries to the **crontabs** files in **/var/spool/cron/crontabs/root** on the control workstation and each of the nodes. The files contain different entries depending on their location.

- Control workstation
  - Merge accounting information
  - Clean up the logs
- Processor nodes
  - Update the **sup.admin, user.admin** and **node.root** file collections
  - Merge accounting information
  - Clean up the logs

The following example shows these entries on a control workstation:

```
 0 * * * * /usr/lpp/ssp/bin/dev/null 2>/dev/null
 0 0 * * * /usr/lpp/ssp/bin/cleanup.logs.ws
0 4 * * 1-6/usr/lpp/ssp/bin/crunacct 2>/var/adm/cacct/nite/accterr
15 5 1 * * /usr/lpp/ssp/bin/cmonacct
```

The default is to run these processes hourly, in a staggered sequence. You can customize this for your environment to make any of these processes run more or less frequently. You can also add your own entries to these files for other processes you want automated.

Updating crontabs on the SP Nodes

If you want the same **crontab** file on all SP nodes, one way to update it across the whole SP System is:

1. Get the current **crontab** from one of the nodes:

   rsh *hostname* crontab -l > /tmp/mycrontab

2. Edit the file:

   ```
   vi /tmp/mycrontab
   ```

3. Propagate the changed **crontabs** file to all SP nodes:

   ```
   dsh -a rcp root@mynode:/tmp/mycrontab /tmp/mycrontab
   dsh -a "crontab < /tmp/mycrontab"
   ```

If you change the default configuration to modify the hierarchy of file collection servers, you need to modify the **crontabs** files to reflect the new relationship. See “Modifying the File Collection Hierarchy” on page 159 for more information. If you create your own file collections, you will also need to add them to the **supper update** commands in the **crontabs** file to keep them on schedule with the other upgrades.

Managing Sets of Nodes

Chapter 14. Using a Switch

Using a switch can be a complex task. You should also consult the following documents:

- *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.
- *PSSP: Installation and Migration Guide*. See the chapter on reconfiguring the system and refer to the section on installing a switch.
- *PSSP: Diagnosis Guide*. See the chapter on diagnosing switch problems.

This chapter describes the purposes of using a switch, as well as the following:

- Understanding the switch and the types supported.
- Switch communication modes.
- Understanding adapter window allocations.
- Primary node takeover.
- System partitioning and the switch.
- Extension nodes and the switch.
- Selecting switch clocks.
- Selecting the primary and primary backup node.
- Managing the switch topology file.
- Starting the switch.
- Automatic unfence of nodes.
- Preparing for system repartitioning.
- Monitoring nodes on a switch.
- Global shutdowns and reboots of nodes with a switch.
- NFS mounts over a switch.

| **Note:** This chapter does not apply to systems comprised of clustered enterprise
| servers since SP switches are not supported on such systems.

Understanding the Switch and the Types Supported

A switch provides a means for nodes to communicate with each other faster and more efficiently. For example, a switch can dramatically speed up TCP/IP, file transfers, remote procedure calls, and relational database functions. A switch consists of a switch assembly and the internal cables to support connections to the processor nodes. A switch can provide some or all (depending upon the type of switch) of the following capabilities:

- Interframe connectivity and communication
- Scalability for increased number of nodes including intermediate switch frames
- Constant bandwidth and latency between node pairs
- Support for Internet Protocol (IP) communication between nodes
- IP Address Resolution Protocol (ARP) support
- Support for dedicated or multi-user environments
- Error detection and retry
- Fault isolation
- Concurrent maintenance for nodes

| The switches that are supported on the SP system are the SP Switch and the SP
| Switch2. The SP Switch connects all the processor nodes on the SP system,
| providing enhanced scalable high performance communication between processor

nodes for parallel job execution. The SP Switch can be ordered with 16 ports for use in a tall SP frame or with 8 ports for use in a short SP frame. The SP Switch2 provides similar and enhanced support in SP systems that have only POWER3 SMP high nodes in tall SP frames. SP switches are not supported with clustered enterprise servers.

Usage Notes

1. Throughout this chapter, use of the term SP switch applies to both the 8-port and 16-port SP Switch and to the SP Switch2 except when specifically stated otherwise. Differences are noted in discussions of system partitioning, switch node numbering, and cabling.
2. Do not set the AIX 4.2.1 base environment variable EXTSHM to ON in the /etc/environment for shared memory segment when PSSP is installed since PSSP functions need to be using the segment boundary instead of the page boundary. The default setting of EXTSHM is OFF and it should not be turned on. For more information on the EXTSHM variable, see the appropriate AIX documentation.

Switch Communication Modes

Two communication protocols are offered for the adapter:

1. AIX sockets using standard IPv4 protocol.
2. Dedicated user space access (via message passing libraries) and multiuser environments (via IP).

Both modes can be used concurrently, as if the adapter was actually two separate adapters.

IPv6 is not supported. See Appendix G, "Tolerating IPv6 Alias Addresses" on page 597 for more information.

Switch Communication Using IP (TCP/IP and UDP/IP)

The switch adapters are configured for IP by default during the installation process. You can assign specific IP network addresses statically during installation or dynamically using ARP (Address Resolution Protocol). When you assign the IP address statically, there are restrictions on mapping of nodes to low order addresses (see the information on switch node numbering in the *PSSP: Installation and Migration Guide*). When you assign the IP address range dynamically using ARP, there are no restrictions.

Any application can communicate over the switch by opening a standard socket and specifying appropriate IP addresses. Additional system facilities based on IP, such as NFS, and licensed programs such as AFS, can also be configured to use the switch. With the possible exception of applications that depend on network-specific functions (LAN broadcasts, for example), most applications work over the switch without modification.

Notes:

1. The **iptrace** command supports both switch adapters and provides interface-level packet tracing for incoming and outgoing packets.
2. The standard AIX commands **ifconfig** and **arp** have been modified to support the switch adapters. Refer to the *PSSP: Command and Technical Reference* for more information.
3. Static routes associated with the switch will not be automatically reconfigured during node reboot. The routes for the switch are associated with the default interface (**en0**) upon reboot because the switch is not available during the phase of system initialization when the static routes are reconfigured. If you want the routes added automatically, IBM suggests that you put them in a script and have the script called as the last entry in **/etc/inittab**.

Switch Communication Using User Space Message Passing

The user space message passing mode supports parallel applications requiring maximum bandwidth and minimum latency. This mode is used by Parallel Environment for AIX to provide their exported message passing interfaces.

This mode uses *adapter windows* which are composed of instances of parallel tasks and protocols (either the Low Level Application Programming Interface (LAPI) or the Message Passing Interface (MPI)). Each adapter window is associated with a protocol and a task. A task running two protocols (such as MPI and LAPI) has two windows associated with it. The number of adapter windows sharing the SP Switch adapter cannot exceed 4. The SP Switch2 supports up to 16 adapter windows. |

For example, four adapter windows, each containing one parallel task and one protocol can share the following switch adapter. Since this is an example using the SP Switch, the number of adapter windows and the number of protocols does not exceed four. |

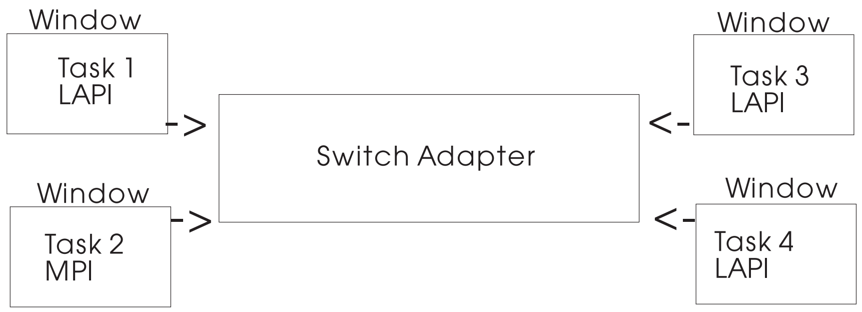


Figure 9. User Space Message Passing

Four adapter windows in the following graphic encompass three parallel tasks and four protocols. The third task uses both LAPI and MPI. Again, in this case the number of adapter windows does not exceed four.

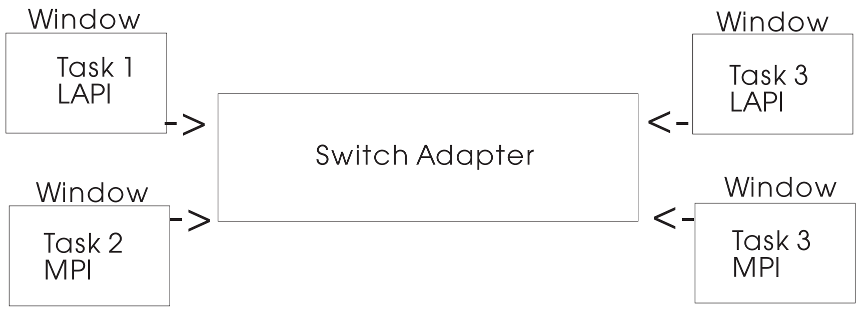


Figure 10. User Space Message Passing

The tasks can be part of the same job or of separate jobs. All tasks in the same job must use the same combination of protocols.

Understanding Adapter Window Allocations

Some SP subsystems such as LoadLeveler, GPFS, and the Virtual Shared Disk component of PSSP, use switch adapter windows. You can also have locally developed applications use switch adapter windows. Any subsystem can reserve an adapter window for its use if it is configured to do so, such as GPFS can be. The maximum number of adapter windows available is reduced by each adapter window that is reserved. On the other hand, an application can be configured to use any available adapter window. For instance, a typical use of available adapter windows is for user space jobs managed by LoadLeveler. LoadLeveler will use one or more available windows until the user space job is done. As a result, LoadLever is capable of using all the adapter windows that are available.

For that reason, it is important to understand the type and amount of workload on your SP system, which and how many subsystems use adapter windows, how many are available, and the sequencing when starting up and shutting down subsystems. It is good practice, for instance, not to start LoadLeveler until after other subsystems that reserve adapter windows have been started. If your SP system runs out of available adapter windows, you need to know which applications you can manipulate or give you options to correct the situation.

Aside from the number of adapter windows, each adapter window uses some amount of *device memory*. Device memory is the total amount of system memory that can be used as interface network buffers. For large parallel user space jobs, the amount of device memory used can be significant. If the amount of device memory is too small, switch communication can be impeded. Before PSSP 3.2, the amount of this resource was not adjustable by customers. The switch communication subsystem simply allocated more and more as it needed to. In PSSP 3.2, the same amount of device memory as in earlier releases is set by default, but you also have the ability to change it if you find a need to. IBM provides default settings that are consistent with those of earlier releases which were not tunable. You do not have to change them unless you need to, based on your SP system's switch communication and workload demands. If you decide you need to consider making changes, see SP tuning information at the Web address **http://www.rs6000.ibm.com/support/sp/**

The **chgcss** command can be used to reserve, release, or query SP switch adapter windows and to change any of the following device memory characteristics:

- The total device memory pool size for adapter windows.
- The minimum amount of device memory for one SP switch adapter window.
- The maximum amount of device memory for one SP switch adapter window.
- The size of the IP receive buffer pool.
- The size of the IP send buffer pool.

For more information about the **chgcss** command, see the book *PSSP: Command and Technical Reference*.

Primary Node Takeover

Error recovery on an SP switch is done locally. Detection and fault isolation are done at the link level while normal traffic flows across the rest of the switch fabric. Detected faults are forwarded to the active primary node for analysis and handling. When the primary node completes assessing the fault, the remaining nodes on the switch fabric are informed of status changes without disruption.

The primary node initializes the switch fabric and processes switch operations and errors reported from the switch fabric. The primary node is no longer a single point of failure on an SP system containing an SP switch.

The primary backup node passively listens for activity from the primary node. When the primary backup node detects that it has not been contacted by the primary node for approximately 7 minutes, it assumes the role of the primary node. This takeover involves reinitializing the switch fabric, selecting another primary backup, and updating the System Data Repository (SDR) without disruption.

The primary node also watches over the primary backup node. If the primary node detects that the primary backup node can no longer be contacted on the switch fabric, it selects a new primary backup node. The criteria to select a new primary backup node follows:

1. First, select a node on a switch assembly other than the switch assembly to which the primary node is attached.
2. Second, if no other switch assembly exists, select a node attached to a switch chip other than the one to which the primary node is attached.
3. If no other switch chip exists, select any available node on the switch chip to which the primary node is attached.

During the period of time between the failure or loss of the primary node and the takeover by the primary backup node, the switch fabric continues to function. Secondary failures are detected during the reinitialization of the switch fabric.

System Partitioning and the SP Switch

As discussed in Chapter 16, “Managing System Partitions” on page 247, the SP system can be organized into groups of nodes for various purposes. You can have multiple system partitions in any system with the SP Switch.

Note: The SP Switch2 does not support multiple SP system partitions. When you use the SP Switch2, the SP system must be configured as the default single system partition. This section applies only to an SP Switch system.

System partitioning has the following implications for the switch:

- Commands related to the switch:
  - **Eannotator** - Operates only within the current system partition
  - **Eclock** - Always operates globally (across system partitions)
  - **Efence** - Can operate globally (**-G**) or only within the current system partition
  - **Eprimary** - Operates only within the current system partition
  - **Equiesce** - Operates only within the current system partition
  - **Estart** - Operates only within the current system partition
  - **Etopology** - Operates only within the current system partition
  - **Eunfence** - Can operate globally (**-G**) or only within the current system partition
  - **Eunpartition** - Operates only within the current system partition
- Switch faults and message traffic are contained *within a system partition*.
- The subset of the switch defined by the topology file for the system partition is viewed as a logical switch.
- There is no connectivity over the switch *between system partitions*. (A gateway node with routing set up to the switch network may require routing changes if the gateway is to remain a gateway for more than one system partition. Use the explicit host routes on the gateway node or enable ARP on all system partitions and redefine the IP addresses within a system partition as a different subnetwork.)
- There remains one switch clock source, regardless of system partitioning.
- There is one primary node per system partition.

Extension Nodes and the SP Switch

Extension nodes are non-standard nodes that extend the SP system's capabilities or scope, but cannot be used in all the same ways as standard SP nodes.

A specific type of extension node is a dependent node. Dependent nodes are
| attached to the SP Switch via a special dependent node adapter. The SP Switch2
| does not support extension nodes.

A dependent node implements much of the switch-related protocol that standard nodes use on the SP Switch, but it depends on standard SP nodes for certain functions. A dependent node can use the SP Switch as an IP network, but it relies upon a standard SP node to generate its switch route table. (The communication subsystem does not send dependent nodes switch topology database updates, but rather generates and sends appropriate switch route tables.)

SNMP support provides for the communication of switch-related configuration information between the SP system and the dependent node.

A dependent node cannot be a primary or primary backup node for the SP Switch.

The **CSS_test**, **Efence**, and **Eunfence** commands operate on dependent nodes in the same way they operate on standard nodes. The **Eprimary** command returns an error message if a dependent node is specified for a primary or primary backup node for the SP Switch. The **Eannotator** command notes dependent nodes in the annotated topology file.

For more information on extension nodes and dependent nodes, refer to Chapter 18, “Managing Extension Nodes” on page 279.

SP-Attached Servers

SP-attached servers are stand-alone servers that attach to the SP control workstation and can have a switch attachment in an SP system that uses a switch. From a switch administration point of view, these nodes are fully functional with an SP Switch. This means, they can serve as a Switch Primary or Primary Backup node just like any other SP node that sits in an SP frame. The SP Switch2 does not support SP-attached servers.

Selecting Appropriate Clocks for the SP Switch

The SP Switch2 does not require you to select switch clocks. This section applies only to the SP Switch. For the SP Switch, one of two switches in the system provides the master switch clock to the rest of the system. If the current master clock fails, or is removed from the configuration, the alternate master clock must be selected and the switch reinitialized.

The **Eclock** command establishes a master clock source after the system is powered up or when an alternate must be selected. It can set the appropriate clock input for every switch in the system or for a single switch after power on. After **Eclock** completes, the **Estart** command must be run.

Warning: Running **Eclock** after the switch is started may cause nodes to lose their clock source. Refer to **Eclock** in the *PSSP: Command and Technical Reference* for more information.

Selecting the Switch Clock Source

To set the SP Switch clock source using SMIT:

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP Systems Management

- The RS/6000 SP Systems Management menu appears.

SELECT RS/6000 SP Cluster Management

- The Cluster Management menu appears.

SELECT Perform Switch Operations

- The Perform Switch Operations menu appears.

SELECT Change/Show Switch Clock Source Settings

- The Change/Show Switch Clock Source Settings menu appears.

At this point, you can select options:

```
Change/Show Switch Clock Source Settings (SP Switch only)

□ List Switch Clock Source Settings
□ Initialize Switch Clock Source Settings
□ Initialize Switch Clock Source Settings for a Switch
□ Restore the Switch Clock Source Settings
□ Select Alternate Switch Clock Source Settings
□ Create an Eclock Topology File
□ Automatic selection of Switch Clock Settings
```

Figure 11. The Change/Show Switch Clock Source Settings (SP Switch only) SMIT Menu

When you choose a switch clock source setting option, you are prompted for a topology file name, and then the **Eclock** command is invoked.

The fastpath invocation for this menu is:

```
smit clock_src
```

Resetting the SP Switch Clock

The switch clock is synchronous across all nodes active on a switch. Its value is set to zero when the primary node powers on, and is later distributed by **Estart** to all nodes on or joining the switch. The switch clock will increase monotonically unless it is reset by one of the following events:

- The switch is powered off.
- An oscillator failure occurs on the switch board designated as the master clock source. (The switch designated as the master clock source provides the clocking signal for all other switch boards within the configuration.)
- The **Eclock** command is issued.
- The **Estart** command is issued while the oncoming primary node (or the primary node on High Performance Switch systems) is not active on the switch (for example, after the primary node is powered on).
- The **Estart** command is issued after **rc.switch** or reboot has run on the primary node, but before the primary backup node has taken over. For further information, see “Primary Node Takeover” on page 225.

Note: IBM suggests that a new primary node that is active on the switch be selected before the old primary node is powered off. This will prevent the switch clock from being reset to zero or to an indeterminate value on High Performance Switch systems. Refer to **Eprimary** in the *PSSP: Command and Technical Reference* for more information on selecting a primary node.

Selecting the Primary and Primary Backup Nodes

On a system with an SP switch, select two standard nodes, one to be used as the primary node and the other to be used as the primary backup node. Note that a dependent node cannot be a primary or primary backup node for the SP Switch. Until the next **Estart** is issued, these nodes are reflected as the oncoming primary and oncoming primary backup nodes (**Eprimary**). Once **Estart** completes, the primary field is updated based on the oncoming primary field and the backup field is updated based on the oncoming backup field.

The criteria to select a new primary backup node follows:

1. First, select a node on a switch assembly other than the switch assembly to which the primary node is attached.
2. Second, if no other switch assembly exists, select a node attached to a switch chip other than the one to which the primary node is attached.
3. If no other switch chip exists, select any available node on the switch chip to which the primary node is attached.

The primary and primary backup fields are updated automatically when primary node and primary backup node failures occur. Therefore, the primary and primary backup fields reflect the state of the current system.

| The following scenario describes how to select a primary backup node on an SP
| switch system.

Initially, the primary node and primary backup node fields are blank. In a 16-node system, the oncoming primary node field has the default value of 1 and the oncoming primary backup has the default value of 16.

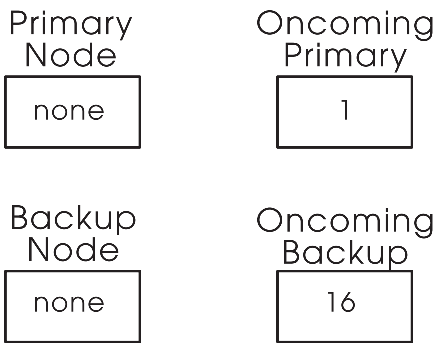


Figure 12. Initial Values

When **Estart** is executed, the node specified in the oncoming primary field becomes the primary node. The node specified in the oncoming primary backup becomes the primary backup.

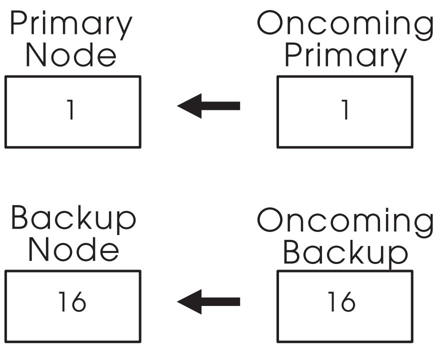


Figure 13. Estart Values

If the primary backup node fails, the primary node automatically selects a replacement.

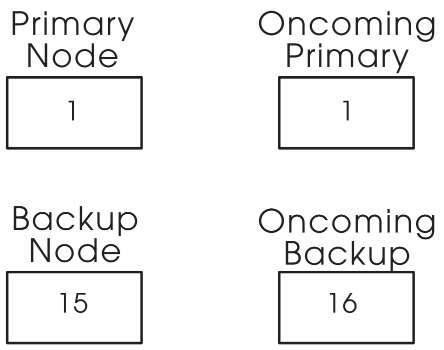


Figure 14. Backup Takeover Values

If the primary node fails, the primary backup node automatically becomes the primary node and a new primary backup is selected.

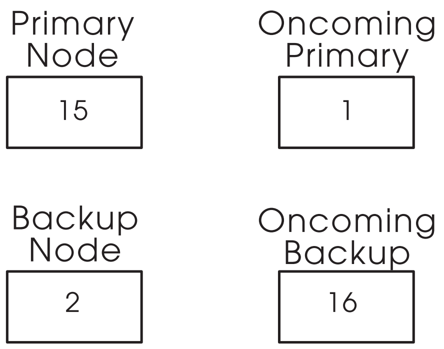


Figure 15. Primary Takeover Values

In summary, primary and primary backup fields reflect the current state of the system and the oncoming fields are not applicable until the next invocation of the **Estart** command.

To select the primary and primary backup nodes using SMIT:

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP Systems Management

- The RS/6000 SP Systems Management menu appears.

SELECT RS/6000 SP Cluster Management

- The RS/6000 SP Cluster Management menu appears.

SELECT Perform Switch Operations

- The Perform Switch Operations menu appears.

SELECT Set Primary/Primary backup Node

- The Set Primary/Primary Backup Node menu appears.

Using the Command Line

On SP Switch systems, to select an oncoming switch primary node and an oncoming switch primary backup node by IP address, use the command:

```
Eprimary 129.33.34.1 -backup 129.33.34.56
```

Managing the Switch Topology File

The switch topology file describes the wiring configuration for the switch; it contains node-to-switch or switch-to-switch cable information. You choose a switch topology file based on the number of **switches** in your SP system. (For more information on choosing a switch topology file, refer to the *PSSP: Installation and Migration Guide* .) You can annotate connection labels onto the selected switch topology file with the **Eannotator** command. Once you have selected and annotated the switch topology file, you store it in the System Data Repository (SDR) with the **Etopology** command. When you start the switch, the switch initialization code reads the switch topology file stored in the SDR. (Refer to the *PSSP: Command and Technical Reference* for more information on the **Eannotator** and **Etopology** commands.)

An **expected.top** file in the **/etc/SP** directory of the primary node overrides the topology file specified in the SDR. (This is used when servicing or debugging the switch. Refer to the *IBM RS/6000 SP: System Service Guide* for more information.)

Annotating a Switch Topology File

Before a switch topology file is stored in the SDR, it should be annotated with **Eannotator**. **Eannotator** will update the switch topology file's connection labels with their current physical locations. If the **-O yes** flag is specified, the topology file is stored in the SDR. Running **Eannotator** makes the switch hardware easier to debug because the switch diagnostics information is printed based on physical locations. The base topology files only contain logical locations. **Eannotator** is required to update jack information for switch diagnostics. For more details on **Eannotator**, refer to the *PSSP: Command and Technical Reference*.

| Note that for an SP switch, if you have annotated your topology file and any nodes have been added, you must re-annotate and store the topology in the SDR. You then must issue the **Estart** command in order to bring any new nodes into the switch network.

Using SMIT

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP Systems Management

- The RS/6000 SP Systems Management menu appears.

SELECT RS/6000 SP Cluster Management

- The RS/6000 SP Cluster Management menu appears.

SELECT Perform Switch Operations

- The Perform Switch Operations menu appears.

SELECT Topology File Annotator

- The Topology File Annotator menu appears.

At this menu:

- Input the name of the topology file to be annotated
- Input the name to which you want the annotated topology file stored
- Enter **yes** to storing the topology file in the SDR

Using the Command Line

To annotate a switch topology file, use the command:

```
Eannotator -F input_file -f output_file -O yes
```

For example, to annotate a topology file for a two-switch or maximum 32-node system:

```
Eannotator -F expected.top.2nsb.0isb.0 -f expected.top.2nsb.0isb.0 -O yes
```

Storing the Switch Topology File in the SDR

Use **Etopology** to store the topology file in the SDR in the current system partition:

Using SMIT

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP Systems Management

- The RS/6000 SP Systems Management menu appears.

SELECT RS/6000 SP Cluster Management

- The RS/6000 SP Cluster Management menu appears.

SELECT Perform Switch Operations

- The Perform Switch Operations menu appears.

SELECT Fetch/Store Topology File

- The Fetch/Store Topology File menu appears.

Input the topology file for your configuration.

Using the Command Line

To store a topology file, use the **Etopology** command:

```
Etopology topology_filename
```

For example, to store a topology file for a two-switch or 32-node maximum configuration:

```
Etopology expected.top.2nsb.0isb.0
```

Starting the Switch

After all the processor nodes are running, you can start the switch using the following procedure:

1. Check that all processor nodes are running (hostResponds indicator).
2. To start the switch, do the following:

a. The fault-handling daemon for the SP Switch (**fault_service_Worm_RTG_SP**) or for the SP Switch2 (**fault_service_Worm_CS**), which checks, initializes, and prepares the switch for operation, must be running on the primary node. If the daemon is not running, use the **rc.switch** command to start the daemon.

b. On the control workstation, run the **Estart** command.

   When **Estart** finishes, it sends a message similar to the following, verifying that it completed:

```
Switch initialization started on tserv10.hpssl.kgn.ibm.com
Initialization successful for 16 nodes
Switch initialization completed
```

c. If the switch initialization process encounters any problems, other messages might appear. If this happens, see the book *PSSP: Diagnosis Guide* and resolve any errors. See the *PSSP: Command and Technical Reference* for more information on **Estart**.

Determining Switch Connectivity

You can monitor switch connectivity to the nodes by using SP Perspectives. For specific information on how to do this, view the online help available from the SP Hardware perspective application.

Automatic Node Unfence

As of the PSSP 3.1 release, the default is for nodes to rejoin the switch communication fabric without any expressed action by the operator. This differs from the default of past releases which required the operator to run either the **Estart** or **Eunfence** commands to get nodes to talk on the switch fabric. This function is built into the fault service daemon and replaces the Emonitor daemon function. Notice that the *autojoin* attribute of the SDR **switch_responds** class is set whenever nodes join the switch fabric. The autojoin attribute being set has the effect of signaling the switch primary node to unfence it once it is fully operational.

With automatic unfence, if you want to fence a node off the switch fabric and not have it rejoin, you must fence the node with the **Efence** command which turns off the autojoin attribute in the **switch_responds** class. If you do not have the autojoin attribute set, the fault service daemon will not unfence it during **Estart** or automatically. The node will remain fenced until either it is unfenced using the **Eunfence** command or the autojoin attribute is set in the SDR.

The following example shows all the states a node **switch_responds** object could be in and how they are treated by the primary.

```
node_number  switch_responds autojoin     isolated     Description
     1            1            X            X         up on switch
     2            0            0            1         Fenced isolated
     3            0            1            1         Fenced with autojoin
```

For the SP Switch2, the pertinent attributes in a node **switch_responds** object are **switch_responds0**, **autojoin0**, and **isolated0**.

When a node is up on the switch fabric, it does not matter how the isolated or autojoin attributes are set. It will remain on the switch until it is fenced, rebooted, or shutdown. The opposite is true of a node that is fenced "isolated". It will remain off the switch fabric until it is unfenced or the autojoin attribute is set. Nodes that are fenced with their autojoin attribute set will get unfenced automatically by the switch primary.

If you do not want to have nodes automatically join the switch, you can turn off automatic unfence. The behavior will be the same as the default of PSSP 2.4 and earlier releases. The *autojoin* attribute will be turned off whenever the node joins the switch. If the node is fenced, it will remain fenced until it is unfenced using the **Eunfence** command. You can still fence individual nodes with the autojoin option which will allow the node to be unfenced automatically when the node is rebooted or when the fault service daemon is restarted.

The default is to have automatic unfence enabled. To turn automatic unfence off (or to enable it again after having turned it off), use the **Estart** command. To turn automatic unfence off, issue the command:

```
Estart -autounfence 0
```

To turn automatic unfence on, issue the command:

```
Estart -autounfence 1
```

See the descriptions of the **Efence**, **Eprimary**, and **Estart** commands in the book PSSP: Command and Technical Reference for more information about using automatic unfence.

Fence the Node From the Switch

To keep a node off the switch fabric that is about to undergo maintenance or service, issue the **Efence** command on the control workstation. For example:

```
Efence node1 node2
```

Once the command completes, powering the node up, powering it down, or rebooting it will not affect the switch.

Return the Node to the Switch

To bring a node previously fenced back into the switch fabric, use the **Eunfence** command on the control workstation. For example:

```
Eunfence node1
```

Alternatively, you can use the Hardware Perspective to unfence the node if it is already powered on. If the node is powered off, you can automatically bring the node back on the switch when powering it on. Display the Power On or Cluster Power On dialog for the specific node, select a power on option and set the “Enable Autojoin - automatically bring the node back in the switch after it is powered up” check box.

The rc.switch /etc/inittab Entry

The rc.switch /etc/inittab entry can be changed from the default of **once** to **wait**. This change, in combination with the autojoin function, will stop the execution of the subsequent entries in the **/etc/inittab** file until the switch's css0 IP interface comes up. This allows for entries that require the switch to be up to be put after the rc.switch entry.

The use of the **once** parameter in the following example indicates that the execution of the subsequent entries will continue in the **/etc/inittab** file until the switch's css0 IP interface comes up:

```
fsd:2:once:/usr/lpp/ssp/css/rc.switch
```

The use of the **wait** parameter in the following example indicates that the execution of the subsequent entries will wait for the switch IP interface to come up before continuing on to run **/etc/inittab**.

```
fsd:2:wait:/usr/lpp/ssp/css/rc.switch
```

The rc.switch will wait for the unfence function to bring up the switch's IP interface after starting the switch's fault service daemon. It will only wait 3 consecutive switch can periods or approximately 6 minutes. After 6 minutes, the rc.switch will return allowing the rest of inittab to be executed.

Preparing the SP Switch for Repartitioning

| This does not apply when you use the SP Switch2 because it does not support
| partitioning. With an SP Switch, use the **Eunpartition** command to prepare the current system partition for repartitioning. For example:

```
Eunpartition
```

Optionally, you can use a SMIT panel to prepare a switch for repartitioning.

Using SMIT

TYPE	**smit**
	• The System Management menu appears.
SELECT	RS/6000 SP Systems Management
	• The RS/6000 SP Systems Management menu appears.
SELECT	RS/6000 SP Cluster Management
	• The RS/6000 SP Cluster Management menu appears.
SELECT	Perform Switch Operations
	• The Perform Switch Operations menu appears.
SELECT	Prepare a switch network for repartitioning
	• The Prepare a switch network for repartitioning menu appears.

See the *PSSP: Command and Technical Reference* for more information on the **Eunpartition** command.

Monitoring Nodes on the SP Switch

| In an SP system with the SP Switch, you can monitor and maximize the availability of nodes on the SP Switch with the **Emonitor** daemon. **Emonitor** is controlled by the System Resource Controller (SRC). One instance of the daemon exists for each system partition and is named **Emonitor**.*partition_name*. A system-wide configuration file, **/etc/SP/Emonitor.cfg** lists all node numbers (one per line) on the system to be monitored.

Emonitor is invoked with **Estart -m**. Once invoked, it is SRC controlled and so will restart if halted abnormally. To end monitoring, run **/usr/lpp/ssp/bin/emonctrl -s** to stop the daemon in the system partition.

Refer to *PSSP: Command and Technical Reference* for more information on **Emonitor**.

SP Switch Admin Daemon (cssadm)

The **cssadm** daemon runs on the control workstation and it subscribes to information provided by the Event Management subsystem to monitor node, node adapter, and switch clock information. If configured to, the daemon provides node and switch clock recovery on the SP Switch. The daemon is started from **/etc/inittab** on the control workstation and is controlled by the SRC subsystem. The SRC subsystem name for this daemon is **swtadm**. The SRC subsystem is not active in an SP system with the SP Switch2.

Selecting the Level of Recovery on the SP Switch

The **cssadm** daemon uses a configuration file to determine the level of recovery you want it to perform. The file is **/spdata/sys1/ha/css/cssadm.cfg**. It contains up to two lines of configuration data as follows:

```
Node 1
Switch 1
```

The first line (Node 1) is present by default. It selects node switch recovery. Set it to zero to disable node switch recovery.

The second line is not included in the file as shipped. It is available so you can select switch clock recovery in SP systems with the SP Switch. Manually add the second line (Switch 1) if you want to configure the **cssadm** daemon to perform switch clock recovery on the SP Switch. If you want to explicitly indicate that switch clock recovery is disabled, add `Switch 0` in the second line.

After you modify the **/spdata/sys1/ha/css/cssadm.cfg** file, stop and restart the **cssadm** daemon using the following commands:

```
stopsrc -s swtadmd
startsrc -s swtadmd
```

To enable the SP Switch power monitoring for switch recovery, you need to modify the **/spdata/sys1/spmon/hmthresholds** file according to the specific instruction within the file. Look for lines similar to those in the following example:

```
  ⋮
# Software thresholding enabled to detect a switch master oscillator failure
# PS1_POWERGOOD set to low threshold at .700
# PS2_POWERGOOD set to low threshold at .700
# In order to enable the thresholding to detect a switch master oscillator
# failure the following line should replace the default thresholds that
# follow the "DO NOT change these values..." line. Please be sure you
# understand the purpose of these thresholds by reading the documentation
# concerning the switch admin daemon (cssadm).
# 0x81 0x00 0xff .700 0xff .700 0xff 0x00 0xff 0x00 0xff 0x00 0xff 0x00 0xff
# Set to 0x00 for defect 47883
#
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
# DO NOT change these values without contacting IBM Support.
#
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 0x81 0x00 0xff 0x00 0xff 0x00 0xff 0x00 0xff 0x00 0xff 0x00 0xff 0x00 0xff
  ⋮
```

Replace the 0x81... line (the last line showing in the example) with the 0x81... line that is currently seven lines above it in the commentary. That line sets .700 in two places that are otherwise 0x00. Then stop and restart the **hardmon** daemon using the following commands:

```
stopsrc -s hardmon
startsrc -s hardmon
```

Node Recovery

Based on information the **cssadm** daemon obtains from the Event Management subsystem regarding the state of nodes and node adapters, the daemon handles the following events:

- Node joins Host membership or node leaves Host membership (IBM.PSSP.Response.Node.state)

  If a node comes up in this state, the node is checked to see if it is the oncoming primary node in its partition. If it is the oncoming primary node, cssadm executes an **Estart.**

  If the **Estart** command fails, a message is written to the cssadm log file and no further action is taken.

- Node leaves Switch Adapter membership (IBM.PSSP.Membership.LANAdapter.state)

  If this node is the primary node, the daemon checks to see if there is an active primary backup node. If there is an active primary backup node, the daemon will not intervene because the primary backup node will begin functioning as the backup. If an active primary backup node does not exist, the oncoming node is checked and if the node is up on host responds, cssadm attempts an **Estart.**

  If this node is not the primary and the primary is "none" in the node's partition, cssadm checks to see if there is an active primary backup node. If there is an active primary backup node, the daemon will not intervene because the primary backup node will begin functioning as the backup. If an active primary backup node does not exist, the oncoming node is checked and if the node is up on host responds, cssadm attempts an **Estart**.

Node event handling operates on a system partition basis. Events from each of the membership groups are handled based on the effect that event would have on that system partition.

HACWS Considerations: In an HACWS environment, do not add an **/etc/inittab** entry to start the cssadm daemon because in the HACWS environment, the HACWS function starts the cssadm daemon on either the primary or backup control workstation.

As stated previously, the **cssadm** daemon interacts with the Event Management subsystem. It also interacts with a configuration file to enable node recovery. The configuration file resides at **/spdata/sys1/ha/css/cssadm.cfg** and it contains one line which reads as follows:

```
Node 1
```

If the value is set to 1, the daemon is triggered by the Event Management events described previously. If you do not want the daemon to react to the events, you can disable node recovery by changing the 1 to a 0 and stopping the **cssadm** daemon by issuing the **stopsrc -s swtadmd** command. After you restart the daemon, the new value in the configuration file will be picked up.

Understanding SP Switch Recovery

Switch recovery is provided for systems with four or less SP Switches. To understand this function you should need a general understanding of SP Switch clocking.

The SP Switch uses a clocking hierarchy. One switch is designated the *master clock switch* for the entire network. All other switches receive clock information from that switch. Each switch must be initially *clocked* before it can join the switch network. This is done by the **Eclock** command. If a switch is powered down and back up, it needs to be reclocked before it can join the network. If the master switch is powered down and back up, then all switches need to be reclocked.

The other event that can happen in the clocking hierarchy is a master oscillator failure, though this is rare. If it occurs, the entire switch network will go down because the master clock will have been lost. In that case, it is necessary to move the master to another switch, if possible, and run the **Eclock** command again for the system.

The switch recovery of the **cssadm** daemon handles all global clocking events. It attempts to determine the state of the system and whether any reclocking is necessary based on the following:

1. The events received from the Event Management subsystem.
2. The hardmon subsystem.
3. SDR information

When global events that affect a master oscillator switch happen, it is usually necessary to alter the clocking topology. Before PSSP 3.2, the Eclock topology files contained only one alternative clocking permutation. Now there are more alternatives based on the number of switches available in the SP system.

When a non-master switch loses its controller responds or is powered off, the **cssadm** daemon makes note of it. When that switch becomes available again, the daemon runs the **Eclock** function to establish its switch clocking. If the master switch goes off, then the daemon looks at the Eclock topology file for an alternative clocking topology and runs the **Eclock** function for the remaining switches with the topology alternative. This causes nodes to go off the switch. If node recovery is enabled, the daemon runs the **Estart** function, otherwise you must run the **Estart** command.

When using switch recovery, some restrictions are necessary in order for the daemon to always be aware of the current state of the switch clocking topology. The following restrictions apply:

- Do not run the **Eclock -s -m** command.
- Do not specify an alternate switch topology file using the **Eclock -f** command.

Stopping and Starting the cssadm Daemon

The daemon is added to SRC as the subsystem **swtadmd** and is started from the **/etc/inittab** file automatically. To stop the daemon, run the command:

```
stopsrc -s swtadmd
```

To permanently stop the daemon from running, remove the subsystem entry from the **/etc/inittab** file.

To restart the daemon, run the command:

```
startsrc -s swtadmd
```

cssadm Log Files

The daemon generates the following log files all located in the **/var/adm/SPlogs/css** directory:

- cssadm.debug

  This file contains trace information of the actions of the daemon. It contains entries for each event received and handled, as well as how the events were handled and the results.

- cssadm.stderr

  This file contains any unexpected error messages received by the daemon while performing commands external to the daemon.

- cssadm.stdout

  This file contains any unexpected informational messages received by the daemon while performing commands external to the daemon. In general, this log should remain empty.

SP Switch2 Admin Daemon (cssadm2)

The **cssadm2** daemon runs on the control workstation. It performs the same node recovery functions for SP Switch2 systems as does the **cssadm** daemon for SP Switch systems. The daemon is started from the **/etc/inittab** file on the control workstation and is controlled by the SRC subsystem. The SRC subsystem name for this daemon is **swtadm2**. This subsystem is inactive on an SP Switch system.

Selecting the Level of Recovery on the SP Switch2

The **cssadm2** daemon uses the **/spdata/sys1/ha/css/cssadm.cfg** configuration file to determine the level of recovery you want. The file contains the following line:

```
Node 1
```

This line is present in the file and selects node switch recovery by default. Set it to 0 if you do not want to have node switch recovery enabled. When the value in this file is modified it is necessary to stop and restart the **cssadm2** daemon as described in "Stopping and Starting the cssadm2 Daemon."

When node recovery is enabled, the **cssadm2** daemon handles the same Event Management events in the same way as described for the **cssadm** daemon.

Stopping and Starting the cssadm2 Daemon

The daemon is added to SRC as the subsystem **swtadm2** and is started from the **/etc/inittab** file automatically. To stop the daemon, run the command:

```
stopsrc -s swtadm2
```

To permanently stop the daemon from running, remove the subsystem entry from the **/etc/inittab** file.

To restart the daemon, run the command:

```
startsrc -s swtadm2
```

cssadm2 Log Files

The daemon generates the following log files all located in the **/var/adm/SPlogs/css** directory:

- cssadm2.debug

  This file contains trace information of the actions of the daemon. It contains entries for each event received and handled, as well as how the events were handled and the results.

- cssadm2.stderr

  This file contains any unexpected error messages received by the daemon while performing commands external to the daemon.

- cssadm2.stdout

  This file contains any unexpected informational messages received by the daemon while performing commands external to the daemon. In general, this log should remain empty.

SP Switch2 Emaster Daemon (emasterd)

The **emasterd** daemon runs on the control workstation and it subscribes to information provided by the Event Management subsystem in order to monitor the health of the Master Switch Sequencing (MSS) node. The MSS node is the node which periodically resequences the time-of-day (TOD) signals on the SP Switch2. The daemon is started from the **/etc/inittab** file on the control workstation and is controlled by the SRC subsystem. The SRC subsystem name for this daemon is **emasterd**. This subsystem is inactive on an SP system with the SP Switch.

MSS Node Recovery

There is no configuration associated with the **emasterd** daemon because its use is required on the SP Switch2 for automatic MSS Node recovery. The **emasterd** daemon handles events received from the Event Management subsystem, such as changes in the IBM.PSSP.Response.Node.state and the IBM.PSSP.Membership.LANAdapter.state resource variables for the MSS node, to determine if the MSS node needs to be changed. If the **emasterd** daemon changes the MSS node, there might be a loss of clock signals to the nodes of up to 30 seconds.

To see which node is the current MSS node, run the **Emaster** command.

Restarting the Emaster Daemon

The daemon is added to the SRC subsystem as **emasterd** and is started from the **/etc/inittab** file automatically. If you ever need to restart the daemon, run the **startsrc -s emasterd** command.

emasterd Log Files

The daemon generates the following log files all located in the **/var/adm/SPlogs/css** directory:

- emasterd.debug

  This file contains trace information of the actions of the daemon. It contains entries for each event received and handled, as well as how the events were handled and the results.

- emasterd.stderr

  This file contains any unexpected error messages received by the daemon while performing commands external to the daemon.

- emasterd.stdout

  This file contains any unexpected informational messages received by the daemon while performing commands external to the daemon. In general, this log should remain empty.

css.summlog Daemon

This daemon provides a summary log of switch-related AIX error log entries from all nodes in an SP in one convenient location on the control workstation. It provides a summary of switch errors across the entire system, ordered by time and tagged with identifying information, which can serve as the starting point for switch-related diagnosis. The name of this file is **/spdata/sys1/ha/css/summlog**.

For additional information regarding switch-related diagnostic information, see the *PSSP: Diagnosis Guide*.

Starting and Stopping the css.summlog Daemon

To stop the daemon from running, issue:

```
stopsrc -s swtlog
```

To permanently stop the daemon from running, remove the subsystem entry from the **/etc/inittab** file.

To restart the daemon, issue:

```
startsrc -s swtlog
```

css.summlog Log Files

The daemon generates the following log files all located in **/var/adm/SPlogs/css**:

- logevnt.out

  This file contains records of errors which occurred in the components running on the node which experienced the error. These components are notified when switch-related error log entries are made, and report the summary data to Event Management for transmission to the control workstation. The log is a text file and may exist on each node.

- summlog.out

  This file contains error information for the daemon which gathers summary log information and writes it to the summary log file. This log is a text file and exists on the control workstation.

Global Shutdowns and Reboots of Nodes with a Switch

It is possible that the primary node may fence all the other nodes, including the primary backup node, if it is not the first node to shut down during a global shutdown or reboot of the entire system. Primary node takeover can also occur if the primary node is shut down and the primary backup node remains up. Running the **Equiesce** command before the shutdown will prevent these situations from occurring. The **Equiesce** command disables switch error recovery and primary node takeover. It is used to shut off the normal error actions when global activities are performed.

The **Equiesce** command causes the primary and primary backup nodes to shut down their recovery actions. Data still flows over the switch, but no faults are serviced and primary node takeover is disabled. The only switch commands that are functional after the **Equiesce** command is issued are **Eannotator**, **Eclock**, **Eprimary**, **Estart**, and **Etopology** commands.

| **Note:** The **Eclock** command applies only to the SP Switch, not to the SP Switch2.

You can disable switch error recovery and primary node takeover from the command line. For example:

```
Equiesce
```

Optionally, you can use a SMIT panel to quiesce the SP Switch.

Using SMIT

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP Systems Management

- The RS/6000 SP Systems Management menu appears.

SELECT RS/6000 SP Cluster Management

- The RS/6000 SP Cluster Management menu appears.

SELECT Perform Switch Operations

- The Perform Switch Operations menu appears.

SELECT Switch Quiesce

- The **Equiesce** command is run.

See *PSSP: Command and Technical Reference* for more information on the **Equiesce** command.

If you are using the node recovery feature of the switch admin daemon, stop the switch admin daemon before you do a global shutdown, reboot, or rc.switch of nodes. To stop the switch admin daemon, run the command:

```
stopsrc -s swtadmd
```

After the global activity is complete restart the daemon. Run the command:

```
startsrc -s swtadmd
```

To reestablish switch recovery and primary node takeover, run the **Estart** command.

NFS Mounts Over a Switch

IBM does not support NFS mounts over the switch in the root (/) directory. If a mount is necessary in the root (/) directory, place the NFS mount elsewhere in the file system with a symbolic link into the root (/) directory. For example:

```
mount -o intr,hard server:/myfs /otherdir/myfs
ln -s /otherdir/myfs /myfs
```

Chapter 15. Using Job Switch Resource Table Services

The Job Switch Resource Table (JSRT) services are used to load, unload, clean, and query Job Switch Resource Tables, and to query switch adapters. These tables are needed by parallel jobs in order to run user space tasks over an SP switch. They do not apply in a system comprised of clustered enterprise servers because such a system does not support use of an SP switch. These services are used by job management systems like LoadLeveler when running user space jobs. See "Switch Communication Using User Space Message Passing" on page 223 and "Understanding Adapter Window Allocations" on page 224 for more information.

These services consist of a set of APIs and commands. The APIs begin with the prefix **swtbl_...**. The commands are **st_status**, **st_clean_table**, and **st_verify**. They are documented in the book *PSSP: Command and Technical Reference*.

Authorization to use the switch table services with DCE is based on the client being a principal in a DCE group:

- **switchtbld-load** grants access to the **swtbl_load_job** and **swtbl_unload_job** APIs.
- **switchtbld-status** grants access to the **swtbl_status** API and the **st_status** command.
- **switchtbld-clean** grants access to the **st_clean_table** command.

If the client and server using the switch table services are not using DCE security services, authentication and authorization for these services is performed as was done before PSSP 3.2. All users are authorized for the **st_status** command and **swtbl_status** API. The effective user id must be root for the **st_clean_table** command, the **swtbl_load_table** API, and the **swtbl_unload_table** API.

Chapter 16. Managing System Partitions

System partitioning is a method for organizing the SP system into non-overlapping groups of nodes for various purposes such as testing new software and creating multiple production environments. System partitioning is supported in SP systems with no switches and in SP systems with the SP Switch. It is not supported in systems with the SP Switch2. System partitioning is also not supported with clustered enterprise servers.

In this chapter we present information on:

- Understanding system partitioning
- Understanding security for system partitions
- Preparing the control workstation before you define system partitions
- Partitioning the system
- Displaying system partition configuration information
- Verifying system partition configuration
- Managing system partition-sensitive subsystems using the **syspar_ctrl** command

For information on accounting and system partitioning, see "Accounting and System Partitioning" on page 208.

Before proceeding with this chapter, after having studied all the planning considerations that apply to partitioning, you should have installed the PSSP software. In doing so, you have automatically created a single default system partition that consists of all the nodes in your SP system. The single default system partition is all you can have if you use the SP Switch2. With the SP Switch you can have multiple partitions. If you now want to select an alternate system partition configuration, the information in this chapter will guide you in selecting, customizing, and applying a system partition configuration.

Understanding System Partitioning

System partitioning is a method for organizing an SP system into non-overlapping groups of nodes that can be dedicated to specific purposes. A group of such nodes (not including the control workstation) is a *system partition*. For example, you may wish to configure a system partition to use for non-disruptive testing when you migrate to a new release of software. Or you might want to configure system partitions for multiple isolated production environments so that the workload in one environment will not interfere with the workload in another environment. Isolation of production environments is achieved by partitioning the switch in such a way that communication paths for different system partitions do not cross each other.

Note that SP-attached servers and dependent nodes can be part of a system partition along with standard SP nodes. Partitioning is performed according to the switch port to which the server or dependent node is connected.

System partitions appear to most subsystems and for most user tasks as logical SP systems. It is important to understand that from an administrative point of view, each system partition is a logical SP system within one administrative domain.

On the control workstation, the administrator is in an environment for *one system partition at a time*. The SP_NAME environment variable identifies the system partition to subsystems. (If this environment variable is not set, the system partition is defined by the `primary:` stanza in the **/etc/SDR_dest_info** file.) Most tasks performed on the control workstation that get information from the SDR will get the information for *that particular system partition*.

In managing multiple system partitions it is helpful to open a window for each system partition. You can set and export the SP_NAME environment variable in each window and set up the window title bar or shell prompt with the system partition name. The following script is an example:

```
sysparenv:
# !/bin/ksh
  for i in 'splst_syspars'
  do
     syspar='host $i | cut -f 1 -d"."'
     echo "Opening the $syspar partition environment"
     sleep 2
     export SP_NAME=$syspar
     aixterm -T "Work Environment for CWS 'hostname -s' - View: $syspar" -ls -sb &
  done
  exit


.profile addition:
# Added for syspar environment setup
  if [ "'env | grep SP_NAME | cut -d= -f1'" = SP_NAME ]
     then
        PS1="[`hostname -s`<p>$SP_NAME] ["'$PWD]> '
     else
        PS1="[`hostname -s`]["'$PWD]>'
  fi
  export ENV
```

As a user, you can check what system partition you're in with the command:

```
spget_syspar -n
```

You can achieve system partitioning either by applying one of a fixed set of supplied configurations or by creating a different system partition configuration and applying it. (See the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment* for specific information on supplied configurations). The **ssp.top** option in the **pssp** install package contains a directory structure with all relevant files for partitioning the system with supplied system partition configurations. In addition, the **ssp.top** option contains the System Partitioning Aid, a tool for creating customized system partitions to suit your needs. Start the System Partitioning Aid from the Perspectives Launch Pad or with the **spsyspar** command. This option must be installed on the control workstation if you are partitioning your system into more than one system partition.

SP Switch Usage Note

If you are repartitioning your system and it has an SP Switch, you must run **Eunpartition**. Failure to do this will produce unpredictable **Estart** results in the new system partitions. The **Estart** command results can range from only the old system partition portion of the new system partition being accessible on the switch, to a complete **Estart** timeout failure. Various recovery scenarios are available. A guaranteed recovery can be accomplished by:

1. Issuing **Eclock** to reset the switch
2. Rebooting all the nodes or issuing a **css_restart_node** on all nodes
3. Issuing **SDRChangeAttrValues switch_responds isolated=0**
4. Issuing **Estart** in each of the system partitions

This recovery scenario is disruptive to all system partitions, even those unaffected by the repartition.

Understanding Security for System Partitions

Planning for your SP system should have included a study of all the planning considerations that apply to partitioning. During that process, you should have determined which authentication services and security configuration to use in each partition. Within a system partition, there are certain authentication rules that govern the setting of the security attributes. These rules apply to the default system partition, and they apply to each additional partition that you might create.

The Syspar class definition in the SDR contains a set of four security attributes for each partition. These attributes are auth_install, auth_root_rcmd, auth_methods, and ts_auth_methods. The rules that govern which values to set for these attributes which represent your security configuration are the following:

1. The auth_install attribute must contain the value `dce` if the ts_auth_methods attribute contains `dce`. It must contain the value `k4` if either the auth_root_rcmd or auth_methods attributes contain `k4` or the ts_auth_methods attribute contains `compat`. The value `std` need not be set because Standard AIX is an implied method with nothing to install.
2. The auth_root_rcmd and auth_methods attributes must have one security method in common. Your plan for setting these attributes in each partition should have been recorded using the authentication planning worksheet in Appendix C of the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.

Each partition has its own set of security attributes. The AIX Remote Command authentication setting on the control workstation is the union of the auth_methods settings for all partitions. The trusted services authentication methods setting on the control workstation is the union of the ts_auth_methods settings for all partitions.

When you need to change the security settings in a partition it should **not** be done as part of the system partitioning process. Changes to existing partitions should be done either before or after the partitioning process. An attempt to change the security settings of an existing system partition by applying a customization file with changed values might result in failures during execution of the **spapply_config** command because the rules have been violated. The **spcustomize_syspar** command will only verify that the values in the custom file do not violate the rules. The values are not checked against the existing partitions until the **spapply_config** command runs.

When partitioning a system by expanding the number of partitions, by collapsing partitions together, or by moving nodes between partitions, follow these guidelines:

1. Do not change the security settings for existing system partitions.
2. Newly defined partitions may have security settings different from those in previously existing partitions.

You can use any setup that does not violate the authentication rules.

For example, you have decided to create two partitions during your initial system installation. The install was started using Kerberos V4. The second partition is to be DCE only. There are two options:

1. During "Step 61: Set Up System Partitions" in the book *PSSP: Installation and Migration Guide*, you can create a custom file containing two Kerberos V4 partitions. After running the **spapply_config** command on the CWS, you can transition the second partition to DCE and Kerberos V4, then to DCE only.

   You would perform all the steps in "Chapter 5. Adding DCE to the SP System" of the book *PSSP: Installation and Migration Guide*, except for rebooting the nodes. Then continue the installation with Step 62.
2. During "Step 61: Set Up System Partitions" in the book *PSSP: Installation and Migration Guide*, you can create a custom file containing Kerberos V4 settings for the original default system partition and DCE settings for the new partition. Additional DCE setup on the control workstation, discussed later, will need to be done both before and after running the **spapply_config** command.

Preparing the Control Workstation Before You Define System Partitions

In the beginning, after you have installed the PSSP software, but before you have configured system partitions, there is one system partition corresponding to the name and IP address of the control workstation returned by the **hostname** command. This is the *default* or *persistent* system partition. It always exists. When you configure more than one system partition, one of them must be defined as the default system partition with this name and IP address and you must define alias IP addresses and names for all other system partitions. In addition, when you add a security method to a system, some steps must be done before partitioning. This section discusses the following procedures that must be completed before you partition the SP system:

- Defining alias IP addresses
- Preparing the control workstation for adding a security configuration

After completing the procedures in this section, proceed with “Partitioning the SP System” on page 253 to select, customize, and apply a system partition configuration.

Defining Alias IP Addresses

When configuring more than one system partition, you must define alias IP addresses and names for all but the default system partition. To configure an alias IP address use the **ifconfig** command with the alias parameter, establishing an additional IP address for the interface to which the **hostname** of the control workstation can map.

Note: The alias must be defined on the same subnet as the interface to which the **hostname** of the control workstation maps. IPv6 aliases are not supported. For more information about IPv6, see Appendix G, “Tolerating IPv6 Alias Addresses” on page 597.

Also add alias names that map to these alias IP addresses through your name resolution mechanism. Add the alias IP addresses to the **rc.net** file so that they are automatically configured when the control workstation reboots.

The steps for defining alias IP addresses are:

1. In the *Part II - Traditional Configuration* section of the **/etc/rc.net** file, a template is provided for changing **inet0** to an alias. Follow the template and edit the file to define alias IP addresses and names. (After editing the **/etc/rc.net** file, make sure that you have execute permission on the file or the control workstation will not boot correctly.) For example:

   ```
   /usr/sbin/ifconfig tr0 alias 129.40.127.101 netmask 255.255.255.0
   up >>$LOGFILE 2>&1;
   ```

2. Execute the **/etc/rc.net** script. Alternatively, you could enter the **ifconfig** command directly. For example:

   ```
   ifconfig tr0 alias 129.40.127.101 netmask 255.255.255.0 up
   ```

3. Validate that the alias is defined correctly (that is, that the same interface is defined for the alias and the control workstation host name). For example, to list the IP addresses and aliases on your system:

   ```
   netstat -in
   tr0   129.40.127   129.40.127.43
   tr0   129.40.127   129.40.127.101
   ```

Note: When you add an alias for the control workstation for the purpose of defining a name for a new system partition, you must run the **setup_server** command on the control workstation to properly define the new **rcmd** principal associated with the new host name alias.

To delete the alias we defined in the previous example, the command is:

```
/usr/sbin/ifconfig tr0 delete 129.40.127.101
```

Remember to comment out or delete any entries you made to define aliases in the **/etc/rc.net** file.

Preparing the Control Workstation for Adding a Security Configuration

Security configuration is a complex task. There are many steps in addition to setting the security attributes in the SDR.

The following steps must be done when adding a security method to a system, and they must be done before the partitioning procedure:

- If Kerberos V4 is added to a system, the **setup_authent** command must be run before the auth_install attribute is changed to include `k4`. Similarly, if a new system partition is to contain Kerberos V4, the **setup_authent** command must have been run before the partition is applied by the **spapply_config** command. The **setup_authent** command might have been run as part of your original system installation or it can be run just before the partitioning process that applies the new Kerberos V4 partition.

  When Kerberos V4 authentication is added for a node, the node must be customized. Use the **spbootins** command to set the node to customize and run **setup_server**. The actual customization will occur when you reboot the node after **spapply_config** execution is complete. If partitioning is being done when the node is already set to install, then customization is not needed.

- If DCE is added to an existing system partition there are several configuration steps in "Chapter 5. Adding DCE to the SP System" of the book *PSSP: Installation and Migration Guide* that must be run.

- If a new partition is to contain DCE, and if it is the first configuration of DCE on the SP system, the DCE configuration steps must be done on the control workstation before applying the new partition.

  You must have DCE cell administrator authority to run the **config_spsec** and **setupdce** commands. They are shown in these procedures as being run from the SP control workstation. Using different option flags, you can run them remotely from any appropriately configured workstation. If you do not intend to run them from the SP control workstation, see the book *PSSP: Command and Technical Reference* for the options available and note your changes in the steps of the procedures where those commands occur.

  The DCE configuration steps on the control workstation are the following:

  1. Make sure that the control workstation has been properly defined as a DCE client in the DCE database. Be sure to have a valid network connection to the DCE primary server for the control workstation and target SP nodes.
  2. Set the DCE hostname for each node in the SDR. For example, enter:

     ```
     create_dcehostname
     ```

  3. Update the SDR with the DCE Master Security and CDS Server host names. For example, enter:

     ```
     setupdce -u -s master_sec_svr -d cds_svr
     ```

  4. Configure SP trusted services to use DCE authentication. You must have cell administrator authority to run this step. The **config_spsec** command gets its input from two files. Since DCE is being configured for the first time, you should consider whether you can use the SP services **/usr/lpp/ssp/config/spsec_defaults** file as is, or if you need to change any of the SP service names using the **/spdata/sys1/spsec/spsec_overrides** file.

     For instance, each partition name can be appended to the group names by using the **:p** option in the **spsec_overrides** file. That way different groups can be defined for each partition. For example, **partition1** could be used to specify the **haem-users** group for a partition called partition1, while **partition2** can be used to specify the **haem-users** group for another partition. Different principles can then be assigned to each group. See

"DCE Entities used by SP Security Services" on page 23 for related information.

To configure SP trusted services to use DCE authentication, enter:

```
config_spsec -v
```

5. Create SP services DCE key files. You must be root with self host (the default) DCE credentials to run the **create_keyfiles** command:

```
create_keyfiles -v
```

- When an existing partition containing DCE is split into two partitions, DCE principles and key files must be created for the new partition before the partition is applied. Two commands are supplied for this purpose and are included in the SMIT Syspar menu (smitty syspar). They are shown in "Step 6: Configure SP Partition-Sensitive Services for using DCE" on page 265.

  All nodes with security settings affected by the system partitioning process should be shutdown as directed in "Step 7: Shut Down All Nodes in the Changing Partitions" on page 265 before the **spapply_config** command is run. Any node that is being newly configured with Kerberos V4 must also be set to *customize* before it is rebooted.

Partitioning the SP System

Be sure you have prepared the control workstation as described in "Preparing the Control Workstation Before You Define System Partitions" on page 250. To partition your SP system, begin by choosing a partitioning configuration suitable for the size of your system. The procedure involves the following steps which are explained in the remainder of this section:

1. Check if the system partition configuration you want is supplied.
2. If the system partition configuration you want is not supplied, use the System Partitioning Aid to generate and save your system partition configuration.
3. Archive the System Data Repository.
4. Select a system partition configuration and layout to apply.
5. Customize (name and specify attributes) the system partitions.

   Notes:

   a. Be prepared with values that have been carefully planned for the SP security authentication configuration.
   b. If you are repartitioning and your system has an SP Switch, you need to run **Eunpartition** in each of the partitions that are going to change. This prepares the switch in those partitions for repartitioning.
6. Configure SP partition-sensitive services for using DCE.
7. Shut down all nodes in changing system partitions.
8. Run the **setup_server** command on the control workstation.
9. Apply the configuration.
10. Complete any DCE configuration.
11. Reboot all the nodes in changed system partitions.

The previous steps are referred to as *partitioning* the SP system. However, if you wish to change or add system partitions, that is, to *repartition*, the steps are the same. For example, if you wish to modify an existing system partition or create a new partition for a new production environment, you would follow these steps to repartition the system.

How to Start

If you know that the system partition configuration that you want exists, start with "Step 3: Archive the System Data Repository" on page 256; otherwise, start with "Step 1: Check if the System Partition Configuration You Want is Supplied" on page 255.

For partitioning or repartitioning the system, you have the option of using SMIT menus or commands. SMIT menus can be accessed with the **smit** command or from the SP Perspectives Launch Pad. (For more information and examples of the commands used in this chapter, see the book *PSSP: Command and Technical Reference*.)

Note

Some of the commands used in system partitioning (**spdisplay_config**, **splstdata -p**, **spapply_config -v**, for example) produce lengthy output. It is helpful to log the output of such commands. For example, to execute the **spapply_config** command while simultaneously logging a copy of the output to the file **/tmp/syspar.log**, enter:

```
spapply_config -v config.4_4_8/layout.3 2>&1 | tee /tmp/syspar.log
```

Using SMIT

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP System Management

- The RS/6000 SP System Management menu appears.

SELECT RS/6000 SP Configuration Database Management

- The RS/6000 SP Configuration Database Management menu appears.

SELECT Enter Database Information

- The Enter Database Information menu appears.

SELECT System Partition Configuration

- The System Partition Configuration menu appears.

Using the SP Perspectives GUI to Access SMIT

TYPE **perspectives &**

- The SP Perspectives Launch Pad appears.

SELECT smit config_data on CWS

- The RS/6000 SP Configuration Database Management menu appears in a separate AIX window.

SELECT Enter Database Information

- The Enter Database Information menu appears.

SELECT System Partition Configuration

- The System Partition Configuration menu appears.

Step 1: Check if the System Partition Configuration You Want is Supplied

Use the System Partitioning Aid to check if the desired system partition configuration is supplied. The System Partitioning Aid can be invoked from the command line or from the SP Perspectives Launch Pad. This section provides examples using the command line interface. (For information on the SP Perspectives GUI to the System Partitioning Aid, invoke the Aid with the **spsyspar** command and view the online help that is available.) Refer to *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment* for more information on using the System Partitioning Aid.

To check if the desired system partition configuration is supplied:

1. Enter information for your desired system partition configuration into a file. The template for this file is **/spdata/sys1/syspar_configs/bin/inpfile.template**.
2. Once you have created the input file, enter:

   ```
   sysparaid input_file
   ```

3. If the desired system partition configuration is found, layout directory information is displayed. Go to “Step 3: Archive the System Data Repository” on page 256.
4. If the desired system partition configuration is not found, a message is displayed indicating so and stating whether the desired system partition configuration is possible or not possible. If the system cannot be partitioned as desired, an error message is output indicating the reason for the failure. If the desired system partition configuration is possible, a snapshot of the switch chips in the system and performance data for each system partition is output to a set of files.
   a. If the system cannot be partitioned as desired, analyze the error message and create another input file specifying an alternative system partition configuration and rerun the **sysparaid** command.
   b. If the desired system partition configuration is possible, review the performance data that is output and, if it is acceptable, proceed to “Step 2: Generate and Save the System Partition Configuration You Want” on page 256.

Refer to the *PSSP: Command and Technical Reference* for more information on the **sysparaid** command.

Step 2: Generate and Save the System Partition Configuration You Want

Once you have determined that the system partition configuration you desire is possible, generate and save it:

```
sysparaid -s layout_name input_file
```

The newly generated system partition configuration layout will be saved to the **spdata/sys1/syspar_configs** directory.

The **smit syspar** command is a fastpath to the System Partition Configuration menu.

Step 3: Archive the System Data Repository

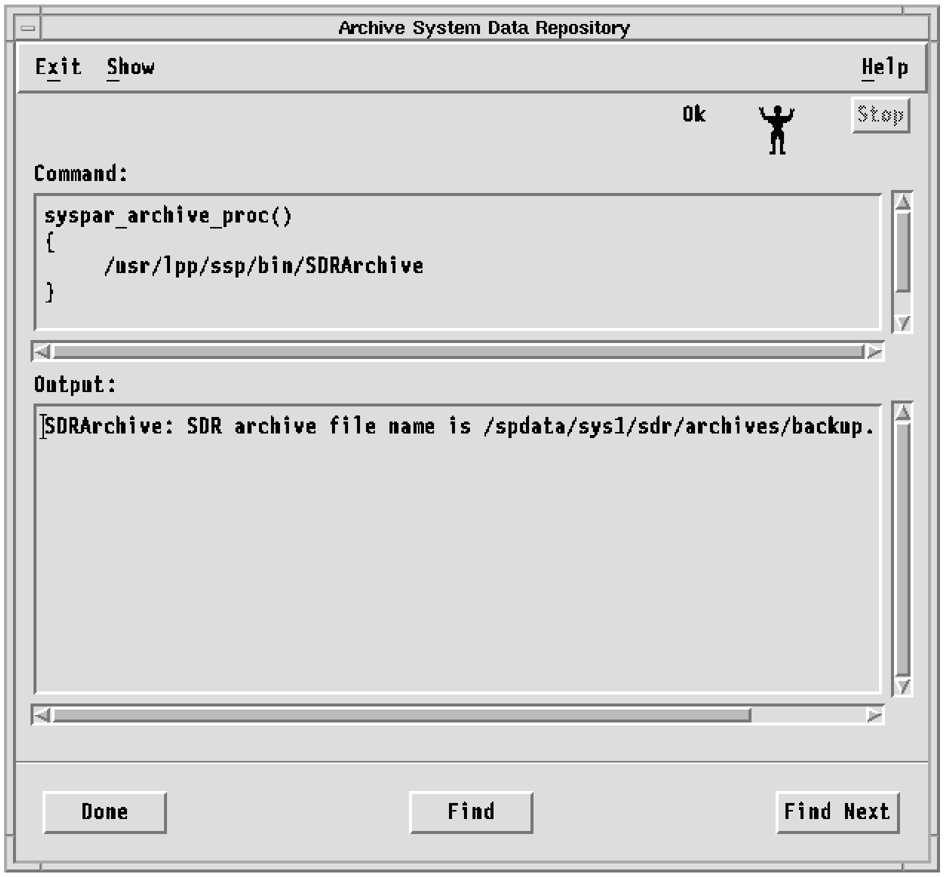
Always archive the System Data Repository before partitioning or repartitioning your SP system. If you change your mind after you have committed a system partition configuration, or if the task applying a system partition configuration fails, you can use the archived SDR to recreate the previous system partition configuration.

Note: When you archive the SDR by using SMIT or the **SDRArchive** command, the archive produced is in **tar** format. Issuing **tar -x** for this archive does not restore the system partition configuration. To restore the system partition configuration, always use the Restore System Partition Configuration option from the SMIT menu.

Using SMIT

At the System Partition Configuration menu:

SELECT Archive System Data Repository



```
syspar_archive_proc()
{
     /usr/lpp/ssp/bin/SDRArchive
}
```

```
SDRArchive: SDR archive file name is /spdata/sys1/sdr/archives/backup.
```

Figure 16. Archive the System Data Repository

Using the command line

Enter:

```
SDRArchive
```

Step 4: Select a System Partition Configuration to Apply

Refer to the chapter "Planning for System Partitions" in *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment* for detailed information on partition schemes for various size SP systems.

To select a system partition configuration to apply:

1. Select a configuration from a list of supported system partition configurations for your SP system
2. Display layout information for the selected system partition configuration
3. Select a system partition layout

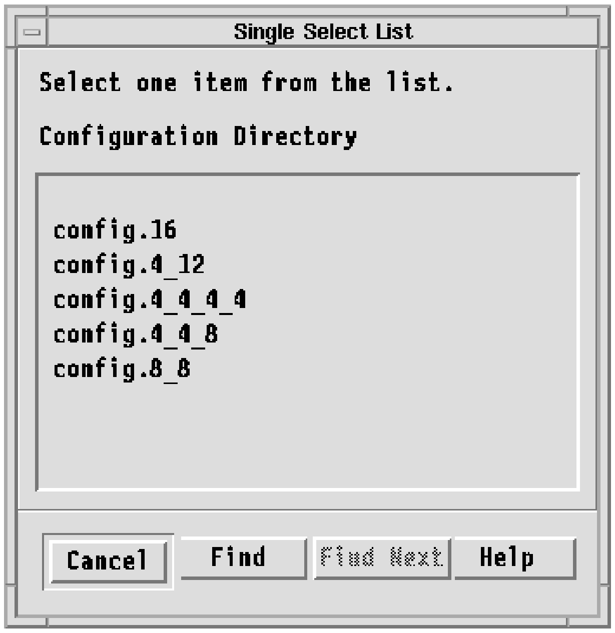
Select a System Partition Configuration

To select a supported system partition configuration for your SP system,

Using SMIT: At the System Partition Configuration menu:

SELECT Select System Partition Configuration

- A list of system partition configurations appears. (If you have created layouts using the System Partitioning Aid, such layouts will also be listed on the SMIT menu.)



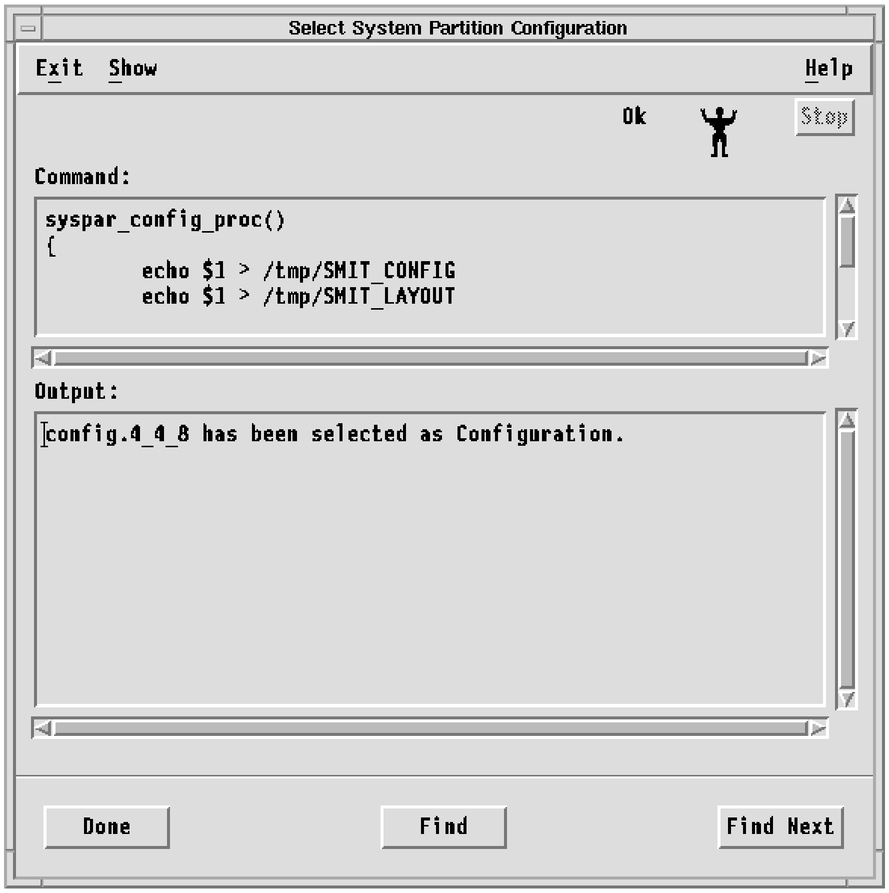
Select one item from the list.

Configuration Directory

```
config.16
config.4_12
config.4_4_4_4
config.4_4_8
config.8_8
```

Figure 17. Select System Partition Configuration

SELECT A system partition configuration



```
syspar_config_proc()
{
        echo $1 > /tmp/SMIT_CONFIG
        echo $1 > /tmp/SMIT_LAYOUT
```

```
config.4_4_8 has been selected as Configuration.
```

Figure 18. Select System Partition Configuration

Using the command line: To display all supported system partition configurations for your SP system, enter:

```
spdisplay_config
```

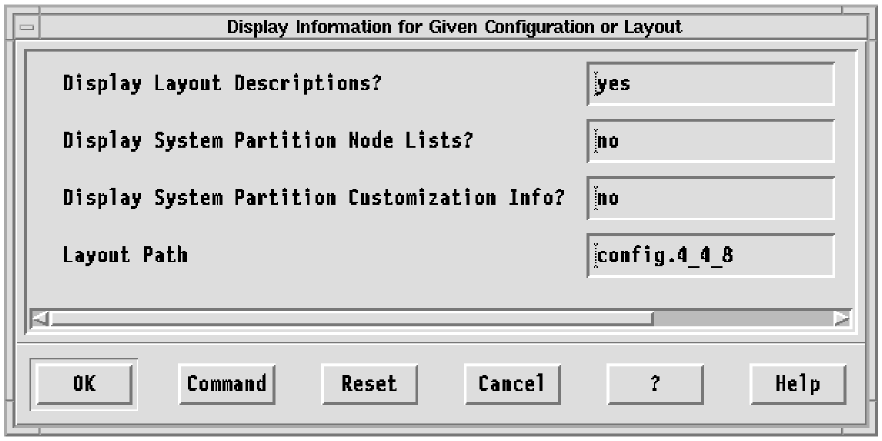
Display Information for the Selected Configuration

To display information about the supported layouts for the system configuration you have selected,

Using SMIT: At the System Partition Configuration menu:

SELECT Display Information for Given Configuration or Layout

- The Display Information for Given Configuration or Layout menu appears.

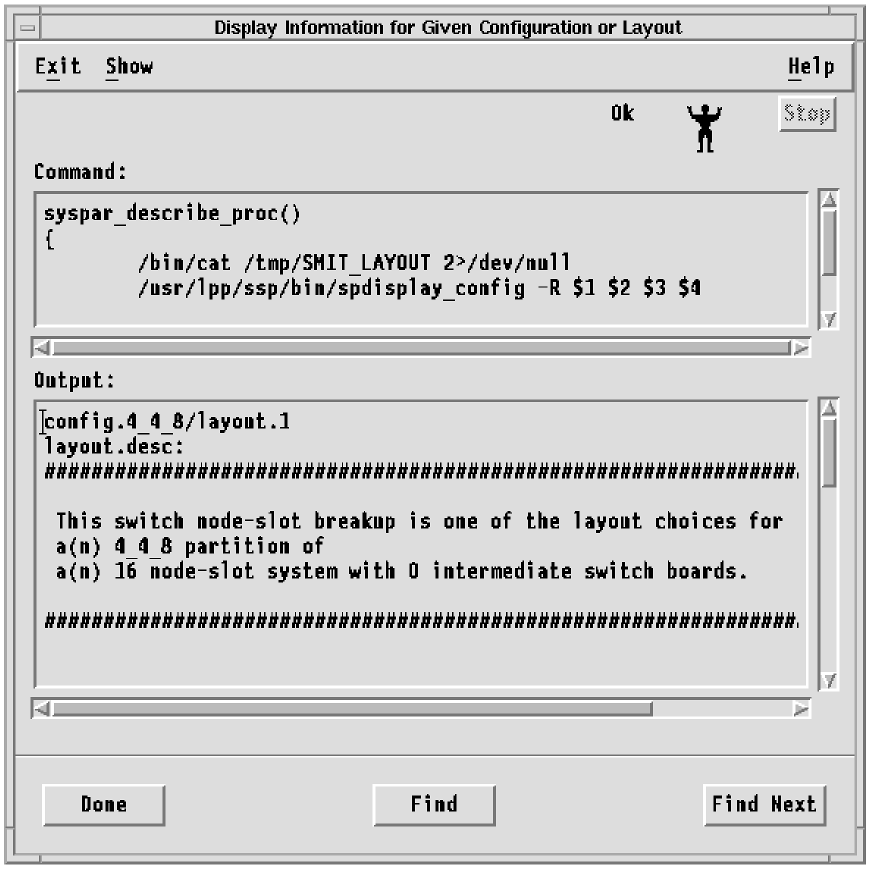


```
Display Layout Descriptions?                      yes
Display System Partition Node Lists?              no
Display System Partition Customization Info?      no
Layout Path                                       config.4_4_8
```

Figure 19. Display Information for Given Configuration or Layout Menu

SELECT OK

- System partition layout information for the chosen system partition configuration appears.



Command:

```
syspar_describe_proc()
{
        /bin/cat /tmp/SMIT_LAYOUT 2>/dev/null
        /usr/lpp/ssp/bin/spdisplay_config -R $1 $2 $3 $4
```

Output:

```
config.4_4_8/layout.1
layout.desc:
######################################################################

 This switch node-slot breakup is one of the layout choices for
 a(n) 4_4_8 partition of
 a(n) 16 node-slot system with 0 intermediate switch boards.

######################################################################
```

Figure 20. Display Information for the Selected Configuration

(This example shows just the first screen of the layout information displayed for our selected 4-4-8 system partition configuration.)

Using the command line: To display information for the supported layouts for the 4-4-8 system partition configuration we've chosen, enter:

```
spdisplay_config -R -d config.4_4_8
```

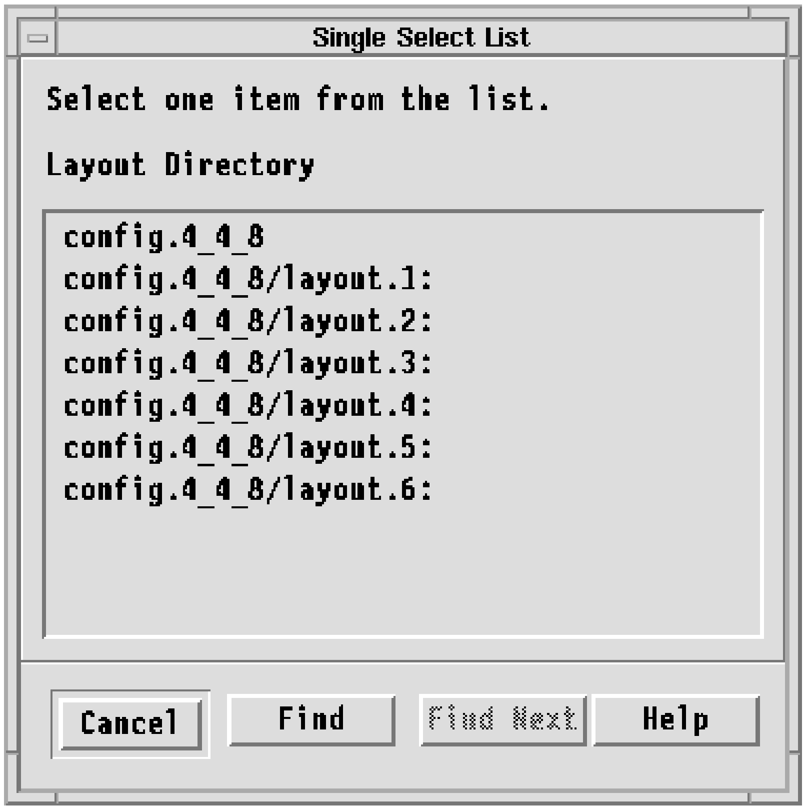
Select a System Partition Layout

Based on the layout information you have displayed for the selected system partition configuration, select a layout,

Using SMIT: At the System Partition Configuration menu:

SELECT Select System Partition Layout

- A list of system partition layouts for the chosen system partition configuration appears. (If you have created layouts using the System Partitioning Aid, such layouts will also be listed on the SMIT menu.)



Single Select List

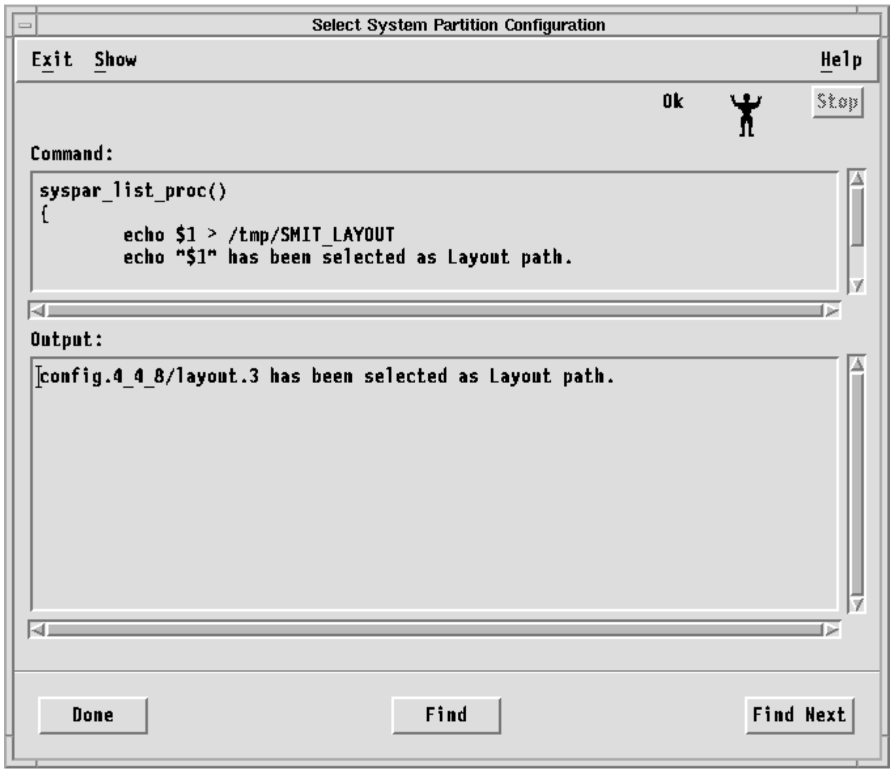
Select one item from the list.

Layout Directory

```
config.4_4_8
config.4_4_8/layout.1:
config.4_4_8/layout.2:
config.4_4_8/layout.3:
config.4_4_8/layout.4:
config.4_4_8/layout.5:
config.4_4_8/layout.6:
```

Figure 21. Select a System Partition Layout

SELECT A system partition layout



Command:

```
syspar_list_proc()
{
        echo $1 > /tmp/SMIT_LAYOUT
        echo "$1" has been selected as Layout path.
```

Output:

```
config.4_4_8/layout.3 has been selected as Layout path.
```

Figure 22. Select a System Partition Layout

In this example, we have chosen layout 3 for our selected 4-4-8 system partition configuration.

Step 5: Customize a System Partition

To customize a system partition, specify information for the following:

- System partition name or IP address
- PSSP code level
- Partition default installation image (optional)
- Primary node (optional)
- Security authentication

Note: Partitioning or repartitioning is never a trivial procedure. Just about every part of the procedure is critical to success. Be fully aware of the following considerations before you proceed:

- Because the customization information is retained in the **custom** file for the partition, the customization step would not have to be repeated when doing a reconfiguration if the same system partition is being used and the customization information does not need to be changed.
- It is imperative that all new IP addresses and host names being used will be resolvable on your SP system.
- If you are repartitioning your system, and your system contains an SP Switch, you must run **Eunpartition** in each of the partitions that are going to change. This prepares the switch in those partitions for repartitioning.
- Be prepared with values that have been carefully planned for the SP security authentication configuration.

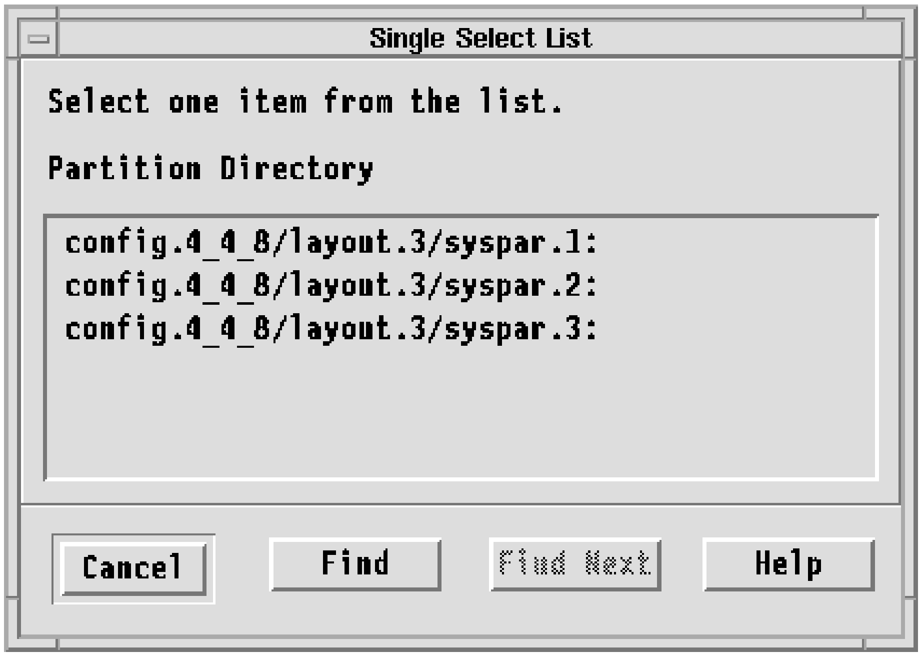
- During repartitioning, you can move nodes from one partition to another. However, in a case where you are not installing or customizing the node, rather you plan to just reboot the node, a fundamental rule applies regarding authentication methods. You cannot directly move a node to disjoint authentication configurations – you must migrate to a configuration within the set that is the union of the authentication methods. For example, to move a node from a partition with an authentication configuration that uses *k4/compat* mode (the value left of the slash is for remote commands and right of the slash is for SP trusted services), to a partition that uses only *dce* mode, first set the node to *k4/compat and dce* mode. Then you can set it to *dce* only. If you are not installing or customizing the node, the newly created partitions need to have the same set of authentication methods as the partition from which the node is moving.
- After all your partitions have been created, do not use the partitioning tools solely to change the security configuration. To change the security configuration without repartitioning, see "Changing the Security Configuration" on page 58.

Using SMIT

At the System Partition Configuration menu:

SELECT Enter Customization Information for a Selected System Partition

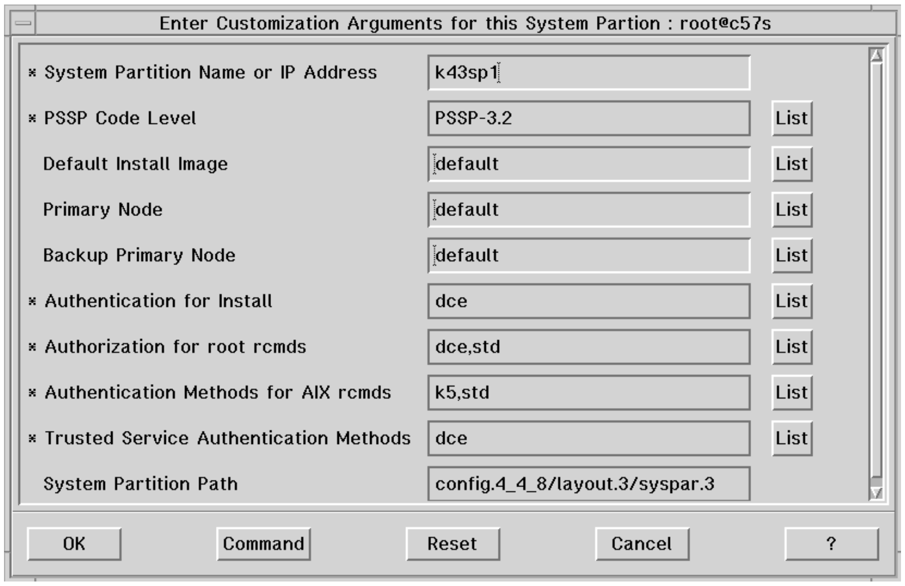
- A list of the system partitions for the chosen configuration layout appears.



```
config.4_4_8/layout.3/syspar.1:
config.4_4_8/layout.3/syspar.2:
config.4_4_8/layout.3/syspar.3:
```

Figure 23. Customize a System Partition

SELECT A system partition and enter customization arguments


Enter Customization Arguments for this System Partion : root@c57s

* System Partition Name or IP Address	k43sp1
* PSSP Code Level	PSSP-3.2
Default Install Image	default
Primary Node	default
Backup Primary Node	default
* Authentication for Install	dce
* Authorization for root rcmds	dce,std
* Authentication Methods for AIX rcmds	k5,std
* Trusted Service Authentication Methods	dce
System Partition Path	config.4_4_8/layout.3/syspar.3

Figure 24. Customize a System Partition

Note: If you have already customized this system partition this menu displays those values. Change the values as desired.

The customization arguments and their meanings are:

System Partition Name or IP Address
The name of the system partition is either the real host name (in the case of the default system partition) or the alias host name of the control workstation. The IP address of the system partition is either the real IP address (in the case of the default system partition) or the alias IP address of the control workstation.

| **PSSP Code Level**
| The PSSP version and release: **PSSP-2.2**, **PSSP-2.3**, **PSSP-2.4**, **PSSP-3.1**, **PSSP-3.1.1**, or **PSSP-3.2**. For system partitions that contain mixed levels of PSSP, this should be set to the minimum, or earliest, level installed in this system partition.

Default Install Image
The name of the **mksysb** image that is used to install a node in this system partition (if the node itself doesn't have an installation image value). For system partitions that contain mixed levels of PSSP, this default install image should be associated with the PSSP code level specified above.

Primary Node
The node on the switch that initializes, recovers, provides diagnosis, and performs other operations to the switch network. The default is the first node in the **nodelist** file.

Backup Primary Node
Available only on SP Switch systems, the node designated as the oncoming switch primary node.

| **Authentication for Install**
| The methods to be installed or configured on each node in the partition.

Authentication for root rcmds
The set of authorization files to be created or updated for AIX root access to remote commands.

Authentication Methods for AIX rcmds
The set of authentication methods to be enabled for AIX root access to remote commands.

Trusted Service Authentication Methods
The set of authentication methods to be enabled for use by SP trusted services.

System Partition Path
The full path name for the configuration, layout, and system partition name.

Using the command line

To list the system partitions for our chosen 4-4-8 system partition configuration, layout 3, enter:

```
spdisplay_config config.4_4_8/layout.3
```

To enter customization information (as shown in our example SMIT menu) for system partition 1 of our chosen 4-4-8 system partition configuration, layout 3, enter:

```
spcustomize_syspar -n k43sp1 -l PSSP-2.2 -d bos.obj.min.41 -e default\
-i dce -r dce,std -m k5,std -t dce config.4_4_8/layout.3/syspar.1
```

Repeat this step, using the appropriate values, for each system partition in the configuration.

Step 6: Configure SP Partition-Sensitive Services for using DCE

In each partition where you want to use DCE security services, prepare the SP partition-sensitive services for using DCE authentication:

1. To make sure that the new partition interfaces are available in the DCE database, run the following command:

   ```
   setupdce -v
   ```

2. The DCE cell administrator must run the following command for each such partition:

   `config_spsec -p` *syspar*

3. The root user with default DCE credentials (self-host) must run the following command for each such partition:

   `create_keyfiles -p` *syspar*

Step 7: Shut Down All Nodes in the Changing Partitions

When you partition or repartition the system, system partitions are considered the same if all of the following are identical:

- Node list files
- Topology files
- PSSP code level
- Default install image
- IP address

- Partition name
- Security settings

If any of the above items are not identical, the system partition is being changed and you need to shut down the nodes in that partition before applying the system partition configuration. If your system contains an SP Switch, run the **Eunpartition** command in each system partition that is being changed. See the **Eunpartition** command in the *PSSP: Command and Technical Reference* for more information.

Note: Modifying only the primary node will not result in a changed system partition. If you want to change the primary node, use **Eprimary** followed by **Estart**. See the **Eprimary** command in the *PSSP: Command and Technical Reference* for more information.

You can use the Verify option on the Apply System Partition Configuration SMIT menu to determine what nodes are changing. The output for the Verify option lists the changing system partitions as well as any nodes in those system partitions that are not shut down.

Using SMIT

At the System Partition Configuration menu:

SELECT Apply System Partition Configuration

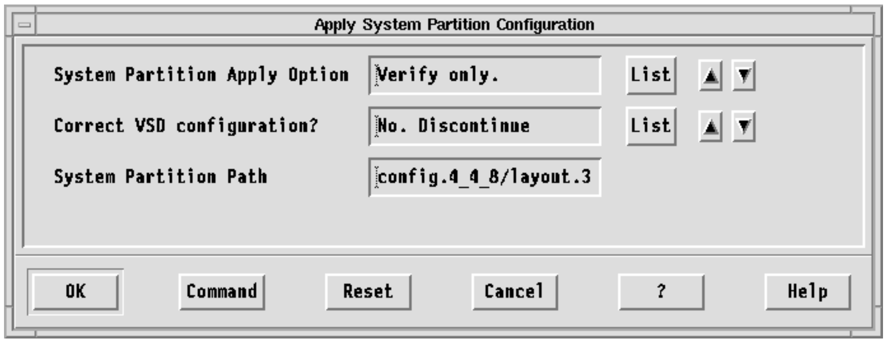
- The previously selected system partition configuration and layout appears.

SELECT The system partition configuration and layout

- The Apply System Partition Configuration menu appears.

SELECT Verify only from the list of System Partition Apply Options

SELECT OK



System Partition Apply Option: Verify only.
Correct VSD configuration?: No. Discontinue
System Partition Path: config.4_4_8/layout.3

Figure 25. Apply System Partition Configuration Menu

The Apply System Partition Configuration arguments and their meanings are:

System Partition Apply Option
The options are provided to either only verify the system partition configuration or to actually apply the system partition configuration.

Correct VSD configuration?
The option to correct or discontinue when nonfatal errors are encountered in the virtual shared disk subsystem in the application of the specified system partition configuration.

System Partition Path

The full path name for the configuration, layout, and system partition name.

Using the command line

Enter:

```
spapply_config -v config.4_4_8/layout.3
```

Step 8: Run the setup_server Command on the Control Workstation

If you have added an alias for the control workstation for the purpose of defining a name for a new system partition (see “Preparing the Control Workstation Before You Define System Partitions” on page 250), you must run the **setup_server** command on the control workstation to properly define the new **rcmd** principal associated with the new host name alias.

Step 9: Apply a System Partition Configuration

When you apply or commit a system configuration, the following occurs:

- The existence of all required files (**nodelist**, **topology**, **custom**) for each system partition in the specified layout directory is verified. In addition, the contents of the **custom** file is checked for completeness.
- Any new system partitions are created on the control workstation.
- The system partition object for each system partition is created in the SDR.
- Affected node objects in the SDR (**Node**, **Adapter**, **host_responds**, **switch_responds**) and affected extension node objects in the SDR (**DependentNode** and **DependentAdapter**) are moved to the newly created partition.
- New **sdrd** daemons are created and started.
- New system partition-sensitive subsystems are created and started via the **syspar_ctrl** command.
- The **Syspar_map** information in the SDR is set for each node slot in the partition.
- The **verparvsd** command is invoked to verify the virtual shared disk data for system partitioning. The command extracts all virtual shared disk data from nodes involved in the system partitioning and writes SDR commands to update the virtual shared disk data to an output file. The output file reloads the virtual shared disk SDR data into the correct new partitions. (Note that the **verparvsd** command can also be used prior to applying a system partition configuration to test the desired layout for the existing virtual shared disk configuration defined in the SDR. See the *PSSP: Command and Technical Reference* for more details.)
- Old unused system partitions on the control workstation, along with their **sdrd** daemons, are deleted and old system partition-sensitive subsystems are deleted.
- | The security settings for each partition are saved in the SDR.
- Updated SDR information is checked for accuracy against the information in the supplied system partition configuration files.

To apply a system partition configuration, be sure you have SDR administrator credentials for all partitions. If DCE is being used and you established separate SDR access groups for each partition using the **/spdata/sys1/spsec/spsec-overrides** file, then you are required to have SDR credentials for all existing partitions and for partitions you are about to create.

Using SMIT

At the System Partition Configuration menu:

SELECT Apply System Partition Configuration

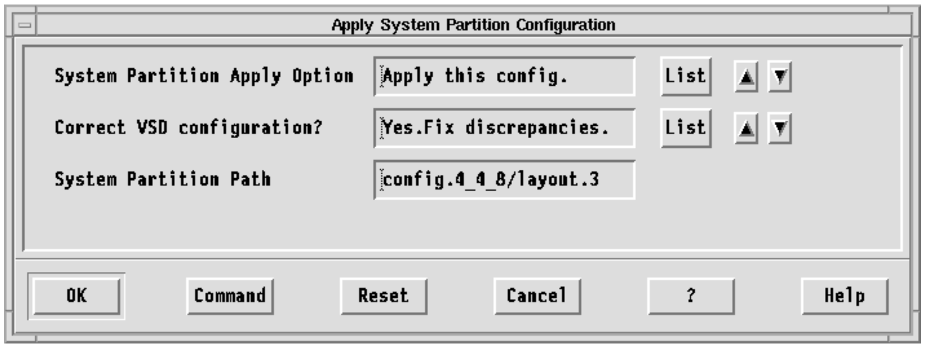
- The previously selected system partition configuration and layout appears

SELECT The system partition configuration and layout

- The Apply System Partition Configuration menu appears.

SELECT Apply this config.

SELECT OK


Apply System Partition Configuration

System Partition Apply Option	Apply this config.
Correct VSD configuration?	Yes.Fix discrepancies.
System Partition Path	config.4_4_8/layout.3

Figure 26. Apply System Partition Configuration SMIT Menu

Using the command line

To apply our chosen 4-4-8 system partition configuration, layout 3, enter:

```
spapply_config -F config.4_4_8/layout.3
```

Important

If a failure occurs at this step, your system is put into an inconsistent state. Use the **sprestore_config** command or Restore System Partition Configuration SMIT menu option to restore the SDR and appropriate system partition-sensitive subsystems from archive.

Note: Due to system partitioning changes, your SP_NAME environment variable might no longer be set to a valid system partition name. To get a list of valid system partition names, use the **splst_syspars -n** command. Then verify that your SP_NAME environment variable is either not set or set to one of the partition names in the list.

|
Step 10: Complete any DCE Configuration.

| If a new partition contains DCE, complete the DCE configuration by configuring the
| admin portion of DCE clients. This command configures the DCE admin portion
| only for nodes in a partition with the **auth_install** attribute set to `dce`. For example,
| enter:

```
setupdce -c cell_admin -l /.:/lan_profile
```

Step 11: Reboot All Nodes in Changed Partitions

| Reboot any nodes that were shut down in “Step 7: Shut Down All Nodes in the
| Changing Partitions” on page 265. Any DCE installation and configuration will be
| done on the nodes using the **spauthconfig** command during the node reboot.

Displaying System Partition Configuration Information

You can display the following information for the system partitions in your current configuration:

- A list of the system partitions in your current configuration
- For each system partition in your current configuration:
  - System partition name
  - IP address
  - Install image
  - Layout directory name
  - IBM Parallel System Support Programs for AIX code version
  - Authorization methods set for root access to AIX authenticated remote commands
  - Authentication methods enabled

Using SMIT

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP System Management

- The RS/6000 SP System Management menu appears.

SELECT RS/6000 SP Configuration Database Management

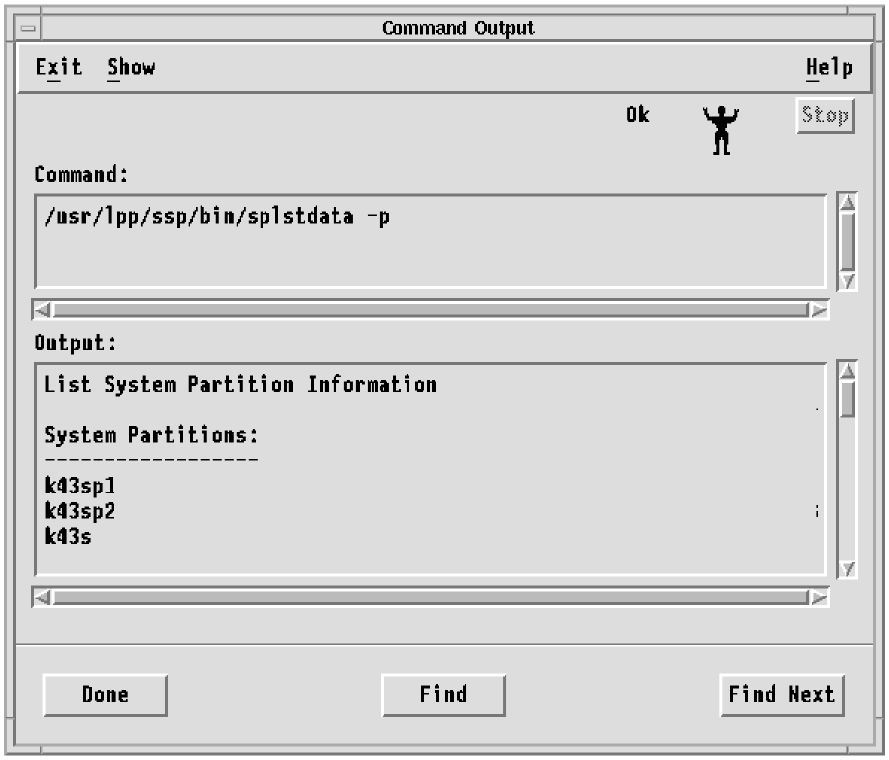
- The RS/6000 SP Configuration Database Management menu appears.

SELECT List Database Information

- The List Database Information menu appears.

SELECT List System Partition Database Information

- The list of system partitions along with information for each of the system partitions appear.



Command:

```
/usr/lpp/ssp/bin/splstdata -p
```

Output:

```
List System Partition Information

System Partitions:
------------------
k43sp1
k43sp2
k43s
```

Figure 27. List System Partition Database Information Output

(This example shows just the first screen of the system partition configuration information for the system partition configuration we have applied.)

The **smit list_syspar** command is a fastpath to the List System Partition Configuration Information menu.

Using the command line

To display information for the system partitions in your current configuration, enter:

```
splstdata -p
```

Verifying System Partition Configuration

You can verify that the system partition information in the SDR is logically consistent.

Using SMIT

TYPE **smit**

- The System Management menu appears.

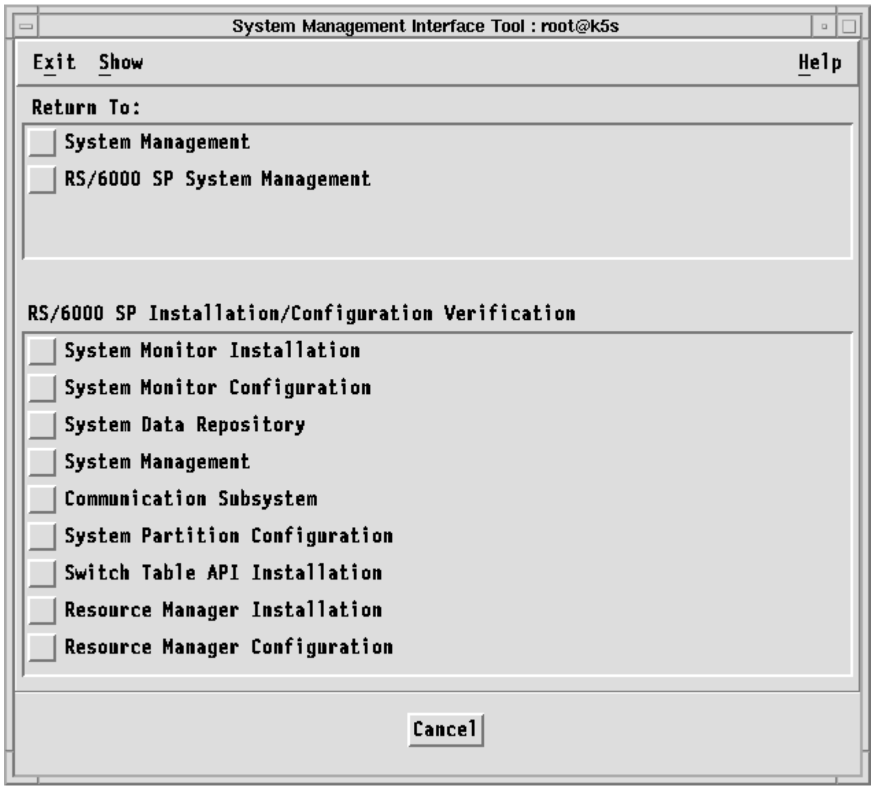
SELECT RS/6000 SP System Management

- The RS/6000 SP System Management menu appears.

SELECT RS/6000 SP Installation/Configuration Verification

- The RS/6000 SP Installation/Configuration Verification menu appears.

SELECT System Partition Configuration


System Management Interface Tool : root@k5s

Exit Show Help

Return To:

- System Management
- RS/6000 SP System Management

RS/6000 SP Installation/Configuration Verification

- System Monitor Installation
- System Monitor Configuration
- System Data Repository
- System Management
- Communication Subsystem
- System Partition Configuration
- Switch Table API Installation
- Resource Manager Installation
- Resource Manager Configuration

Cancel

Figure 28. Verify System Partition Configuration SMIT Menu

The **smit SP_verify** command is a fastpath to the Verify System Partition Configuration SMIT menu.

Using the command line

Enter:

```
spverify_config
```

If the **spverify_config** command runs successfully, the SMIT status indicator will display **OK**.

Managing System Partition-Sensitive Subsystems Using syspar_ctrl

Some of the subsystems that run in the SP environment operate within the domain of a system partition, rather than the domain of the system as a whole. These subsystems are said to be **system partition-sensitive**.

To help you manage these subsystems, PSSP includes the Syspar Controller, which operates through the **syspar_ctrl** command. With this command you can add, start, stop, refresh, and delete system partition-sensitive subsystems, as well as control other aspects of their operation, such as tracing.

The **syspar_ctrl** command provides a single interface to the control scripts for the system partition-sensitive subsystems, which perform the real work of configuring and operating the subsystems.

Listing the System Partition-Sensitive Subsystems

To list the system partition-sensitive subsystems that are managed by the Syspar Controller and their control scripts, enter:

```
syspar_ctrl -E
```

In response, the system displays information similar to the following:

```
Syspar Controller managed subsystems and control scripts:
  hats       /usr/sbin/rsct/bin/hatsctrl
  hags       /usr/sbin/rsct/bin/hagsctrl
  haem       /usr/sbin/rsct/bin/haemctrl
  hr         /usr/lpp/ssp/bin/hrctrl
  pman       /usr/lpp/ssp/bin/pmanctrl
  emon       /usr/lpp/ssp/bin/emonctrl
  sp_configd  /usr/lpp/ssp/bin/sp_configdctrl
  emcond     /usr/lpp/ssp/bin/emconditionctrl
```

Chapter 17. Managing Node Groups

Node grouping is a persistently saved naming facility for sets of nodes: nodes can be grouped together so that they can be acted on as an individual entity. Many system management commands can accept a node group as an argument, causing the action to be performed on each node in the node group. Node groups can be created and managed through a command line interface, SMIT panels, and the SP Hardware Perspective.

This chapter provides information on understanding and working with node groups, as well as using node group commands.

Understanding Node Groups

A node group is a set of nodes whose members may be individual nodes and other node groups. Individual nodes that belong to a node group are *member nodes*; node groups that belong to a node group are *member node groups*. Node groups containing only nodes are *flat node groups*; node groups containing node groups are *hierarchical node groups*. Any node group can be resolved into a flat version that contains only valid member nodes.

Dependent nodes cannot be part of a node group but SP-attached servers can be part of a node group just like any other standard SP node.

Commands, except those that directly manage the node groups, issued against a node group have the same effect as issuing the commands against the set of nodes that represent the flat version of the node group.

Node Group Information in the SDR

Node groups are stored persistently in the SDR. A node group in the SDR is made up of two components: a name and a definition list. A node group name must start with an alphabetic character (A-Z, a-z), but can then contain a sequence of alphanumeric characters (A-Z, a-z, 0-9), a period (.) or an underbar (_). (Thus named, node groups can be easily differentiated from node objects, whose names are a string of numeric characters representing the node number.) A node group name may not contain spaces. The definition list of a node group is made up of a list of nodes and node groups that belong to the node group directly, (not through member node groups).

Node Group Modes

Some node groups exist within a system partition (*partition-bound* node groups or *local* node groups) and some node groups ignore system partition boundaries (*global* node groups). Partition-bound or local node groups can be accessed only within the context of the system partition they belong to. Global node groups are not bound to any system partition, but can be acted on only by commands that accept the **-G** flag or when using the SP Perspectives GUI with a Global view of the SP system. Partition-bound and global refer to the *mode* of the node group.

Partition-bound node groups (local node groups) are stored in the partitioned SDR class **NodeGroup**. Global node groups are stored in the system SDR class **SysNodeGroup**. Valid member nodes of a partition-bound node group must be node numbers that are defined in that particular system partition. Valid member nodes of a global node group are node numbers that are defined in that particular SP system (the union of all nodes in each system partition). Any node number or node group can be added to the definition list of a node group, but only valid member nodes or valid member node groups will be used when resolving (flattening) the node group.

Note: The global name space and the partition name spaces are mutually exclusive for node groups.

Most SP system end users work within system partitions and, therefore, will use partition-bound node groups.

System Administrators, however, will often find it necessary, and advantageous, to work with global node groups. The use of global node groups allows a System Administrator to perform certain tasks, such as installing a daemon on specific nodes or powering off and reconfiguring all nodes on which a given application is running, without regard to system partitions.

Partition-bound node groups and global node groups are different, but they both function to provide a naming facility for sets of nodes.

Considerations for Creating and Resolving Node Groups

When creating a node group or adding to an existing node group's definition list, you can use the command line interface or SMIT panels to add any node number or node group. The member node group does not need to have been defined at the time it is added to another node group's definition list. The member node does not have to be a valid node number for a system partition or even the SP system at the time it is added to another node group's definition list. In this way, you can create node groups to accommodate future growth or changes, such as adding nodes or repartitioning your SP system.

Only users that have the appropriate authority to modify objects in the SDR can create, modify or delete node groups. Any user that has the appropriate authority to read objects from the SDR can reference existing node groups. Any user can modify or reference node groups created by other users, provided they have the appropriate SDR authority. For more information on the authority needed to access the SDR, refer to “Authorization” on page 538.

When a node group is resolved into its flat version, only valid member nodes will appear in the flat version and only valid member node groups will be resolved recursively to produce the flat version. If a node group is a partition-bound node group, when it is flattened all of its member nodes and member node groups must be defined in the same system partition; if they are not, they will not be used to produce the flat version of this node group. If the node group is a global node group, when it is flattened all of its member nodes must be node numbers for the system and member node groups must also be defined as global node groups. Member nodes or member node groups that do not correspond to entities in persistent storage will be ignored when producing a flat version of the node group. A node group's flat version can be empty.

The following is a simple example of how a partition-bound node group will be resolved into a flat list of node numbers.

```
system partition P1 contains nodes 1, 2, 5, 6, 9, 10, 13, 14
system partition P1 contains node groups A, B, C
Node Group A name = A; definition list = 1, 2, B, C, D
Node Group B name = B; definition list = 1, 2, 3, 4, 5, 6
Node Group C name = C; definition list = 13, 14
flat(A) = nodes 1, 2, 5, 6, 13, 14
flat(B) = nodes 1, 2, 5, 6
flat(C) = nodes 13, 14
```

Notes:

1. Nodes 3, 4 are not in flat(A) or flat(B) because they are not part of partition P1.
2. Node group D has no effect on the flat(A) because node group D is not defined in partition P1.

Working with Node Groups

You can use a command line interface, SMIT panels, and the SP Hardware Perspective for working with node groups. Refer to *PSSP: Command and Technical Reference* for a complete description of commands. For information on using the SP Hardware Perspective to create and manage node groups, refer to the online help.

You can use the following commands to create, modify, and delete node groups:

ngcreate	Creates and optionally populates a named node group.
ngnew	Creates new node groups in persistent storage.
ngaddto	Adds specified nodes and node groups to named node group.
ngdelfrom	Removes specified nodes and node groups from named node group.
ngdelete	Removes node groups from persistent storage.
ngclean	Removes nodes and node groups that do not currently exist from specified node groups or every node group in the current system partition.

You can use the following commands to display node group information to standard output:

ngresolve	Displays a list of nodes in the node group.
nglist	Writes a list of all persistent node groups.
ngfind	Writes a list of all node groups containing the supplied node or node group.

Using SMIT

To access SMIT panels (using the fastpath invocation) for creating, modifying, and deleting node groups:

TYPE **smit nodegroups**

- The Node Group Information menu appears.

SELECT Partition Node Groups OR System Node Groups

- The Partition Node Groups or System Node Groups panel appears.

To access SMIT panels (using the fastpath invocation) for examining existing node groups:

TYPE **smit list_nodegroup**

- The List Node Group Database Information menu appears.

SELECT Examine Partition Node Groups OR Examine System Node Groups

- The Examine Partition Node Groups or Examine System Node Groups panel appears.

To access SMIT panels (using the fastpath invocation) for deleting node groups:

TYPE **smit delete_nodegroup**

- The Delete Node Group Information menu appears.

SELECT Delete Partition Node Groups OR Delete System Node Groups

- The Delete Partition Node Groups or Delete System Node Groups panel appears.

Using SP Hardware Perspective

To create a node group:

1. Ensure that the Node Groups pane is displayed and is current.
2. Select Actions → Create Node Group. The Create Node Group window appears.
3. Add the name of the node group, member nodes, and other requested information.
4. Click Apply.

To modify a node group:

1. Select a node group from the Node Groups pane.
2. Select the Notebook icon from the tool bar. The notebook for that node group appears.
3. Modify the information in the notebook for that node group.

To delete a node group:

1. Select a node group from the Node Groups pane to remove.
2. Select Actions → Remove Node Group.

To view node group properties:

1. Select a node group from the Node Groups pane.
2. Select the Notebook icon from the tool bar. The notebook for that node group appears.
3. View the information in the notebook for that node group.

Using Node Groups with Commands

The following commands will accept a node group as an argument. The node group may be supplied as an operand, if this is what is most consistent with the existing syntax. Some commands use the **-N** flag to indicate a node group. Refer to *PSSP: Command and Technical Reference* for actual syntax for each command.

- **cshutdown**
- **cstartup**
- **dsh** (can be used to run a command on every node in a flattened node group)
- **Efence**
- **Eunfence**
- **hostlist**
- **pmandef**
- p-commands

  The following commands all pass arguments to **hostlist**. **hostlist** accepts a node group as an argument, so these commands get node group support through **hostlist**:
  - **p_cat**
  - **pcp**
  - **pdf**
  - **pexec**
  - **pexscr**
  - **pfck**
  - **pfind**
  - **pfps**
  - **pls**
  - **pmv**
  - **ppred**
  - **pps**
  - **prm**
- **spacctnd**
- **spadaptrs**
- **spbootins**
- **spdeladap**
- **spdelnode**
- **spethernt**
- **sphostnam**
- **sphrdwrad**
- **splst_versions**
- **splstdata**

Chapter 18. Managing Extension Nodes

This chapter provides the following information:

- Understanding extension nodes and extension node adapters
- Implementing extension nodes and extension node adapters
- Transferring configuration information for extension node adapters
- Adding extension nodes and extension node adapters
- Changing extension nodes and extension node adapters
- Removing extension nodes and extension node adapters
- Reconfiguring extension nodes and extension node adapters
- Resetting extension nodes and extension node adapters
- Listing extension node and extension node adapter information

For switch-related information on extension nodes, refer to "Extension Nodes and the SP Switch" on page 226.

Understanding Extension Nodes

Extension nodes are non-standard nodes that extend the SP system's capabilities or scope, but cannot be used in all the same ways as standard SP nodes. Extension nodes are attached to the SP Switch via a special **extension node adapter**.

A specific type of extension node is a **dependent node**. A dependent node depends on SP nodes for certain functions, but implements much of the switch-related protocol that standard nodes use on the SP Switch.

SMIT menus and commands are provided for adding configuration information about extension nodes to the SDR. Once this information has been entered into the SDR, a Simple Network Management Protocol (SNMP) Manager daemon that runs on the control workstation (the SP SNMP Manager) allows the transfer of extension node configuration information to the SNMP Agent running on the extension node.

Specific Implementations of Extension Nodes and Extension Node Adapters

An RS/6000 SP Switch Router can be connected to the SP Switch via the RS/6000 SP Switch Router Adapter. The RS/6000 SP Switch Router Adapter provides a high performance, 100 MB/s, full duplex interface between the SP Switch and the SP Switch Router.

When the RS/6000 SP Switch Router Adapter is installed in an SP Switch Router, it allows the switched IP router to be used as a networking gateway for the SP. The SP Switch Router may be populated with additional adapters for standard network interfaces, including Ethernet 10/100BaseT, FDDI, ATM OC3c, SONET OC3c, ATM OC12c, HIPPI and HSSI. More than one RS/6000 SP Switch Router Adapter may be installed and connected to the same SP system or system partition or to other

SP systems. When multiple RS/6000 SP Switch Router Adapters are installed and connected to more than one SP system or system partition, they may be used to provide a high bandwidth link between SP systems or system partitions and to provide the SP systems or system partitions with a shared set of interfaces to external networks.

Each RS/6000 SP Switch Router Adapter requires one available node switch port on the SP Switch that meets the criteria for valid extension node ports as described in *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment.* A 10 meter SP Switch cable and a 10 meter ground strap are provided for connecting the RS/6000 SP Switch Router Adapter, located in the SP Switch Router chassis, to the SP Switch.

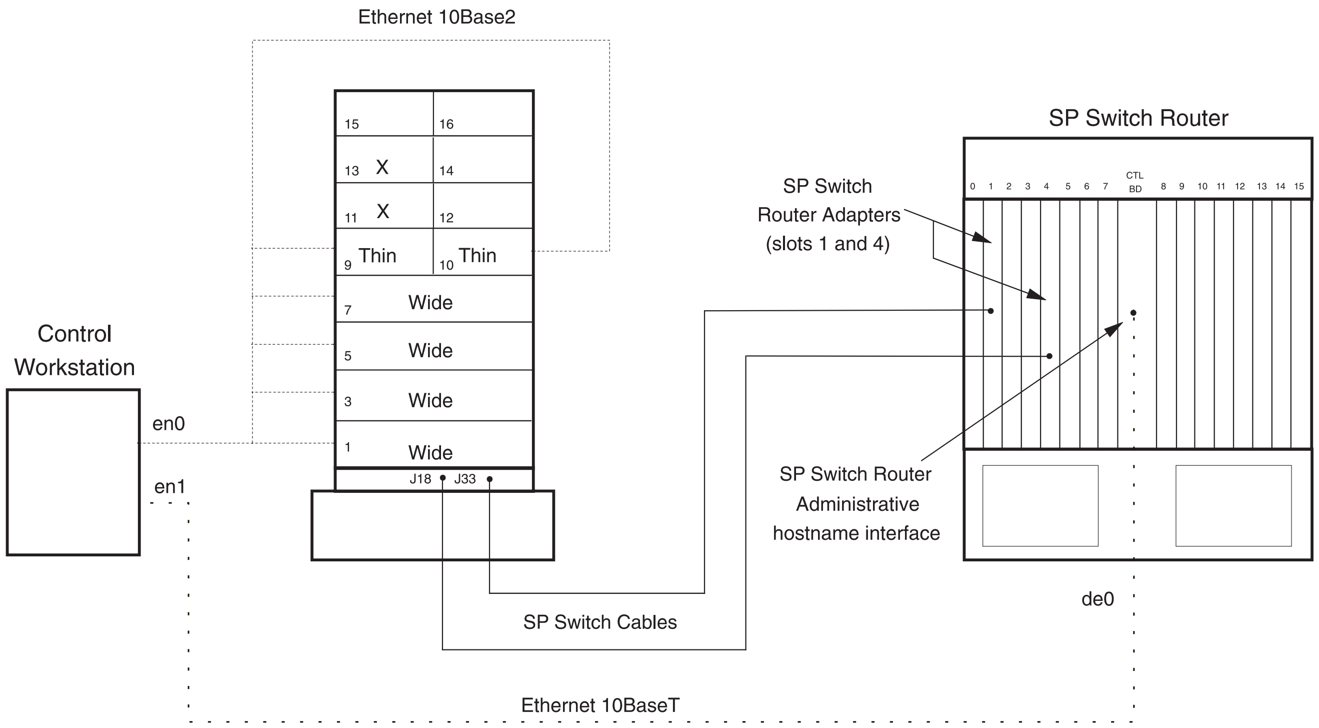


Figure 29. The RS/6000 SP Switch Router and SP Switch Router Adapter Extension Node Implementation

Extension Node Attribute Values

When you add information to the SDR for an SP Switch Router and the RS/6000 SP Switch Router Adapter (see "Adding Extension Nodes and Extension Node Adapters" on page 281), specify the following extension node attributes as described:

Administrative Hostname	The fully-qualified host name of the administrative Ethernet network on the SP Switch Router.
Extension Node Identifier	The 2-digit slot number on the SP Switch Router where the RS/6000 SP Switch Router Adapter is located.
SNMP Agent Hostname	The fully-qualified host name of the administrative Ethernet network on the SP Switch Router.

For more information on configuring the SP Switch Router and RS/6000 SP Switch Router Adapter as extension nodes for the SP system, see:

- *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*
- *PSSP: Installation and Migration Guide*
- *SP Switch Router Adapter Guide*

Transferring Extension Node Configuration Information

After you have used SMIT menus or commands to enter extension node information into the SDR, the SP SNMP Manager running on the control workstation allows the transfer of extension node configuration information to the SNMP Agent running on the extension node.

Refer to "Understanding Network Management" on page 422 for a high-level overview of Simple Network Management Protocol (SNMP).

The SP SNMP Manager daemon, **spmgrd**, runs on the control workstation and treats each extension node as a managed node, with a corresponding SNMP Agent. The SP SNMP Manager waits for trap messages from extension node SNMP Agents reporting state changes or requesting configuration information and sends configuration information to the SNMP Agents when requested. For more information on **spmgrd**, See the book *PSSP: Command and Technical Reference.*

An SNMP Agent may be responsible for one or several extension nodes attached to the SP Switch. The SNMP Agent maintains configuration information for each of its extension nodes in the SNMP Management Information Base (MIB). When an SNMP Agent needs configuration information for one of its extension nodes, it sends a trap message to the SP SNMP Manager responsible for that extension node. The SP SNMP Manager extracts the requested information from the SDR and sends it to the SNMP Agent.

See "ibmSPDepNode.my" on page 504 for a copy of the MIB for dependent nodes.

Adding Extension Nodes and Extension Node Adapters

You can add information for extension nodes and extension node adapters into the SDR by using either the SMIT or command line interface.

If the SP Switch has already been started, you must run **Estart** after you add an extension node and extension node adapter.

From SMIT

1. Access the Extension Node Database Information menu:

   ENTER **smit enter_extdata**

   - The Extension Node Database Information menu appears.

2. Add information to the SDR for extension nodes:

   SELECT **Enter Extension Node Information**

   - The Enter Extension Node Information menu appears.

a. Enter values for the following extension node attributes:

Administrative Hostname	The fully qualified host name associated with the extension node's network interface on its system's administrative network. This name must resolve to an IP address. *Required*.
SNMP Community Name	The Simple Network Management Protocol (SNMP) community name for the authentication field in SNMP messages exchanged by the extension node's SNMP Agent and the SP SNMP Manager. This value can be 1 to 255 ASCII characters.
Extension Node Identifier	The string assigned to the extension node in its system's administrative environment. This string uniquely identifies the extension node to its system and can be 2 to 255 ASCII characters. *Required*. (See "Specific Implementations of Extension Nodes and Extension Node Adapters" on page 279 for more information.)
SNMP Agent Hostname	Host name that resolves to an IP address that is the source or destination of SNMP packets exchanged with the control workstation via the SP administrative network. *Required*.
Reconfigure the extension node?	**yes** or **no**. **yes** notifies the SNMP Agent on the extension node that extension node information has been added or changed. This notification causes the SNMP Agent on the extension node to request configuration information from the SP SNMP Manager on the control workstation.
Node Number	The node number that corresponds to the valid unused switch port assigned to the extension node. *Required*. See *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment* for information on switch node numbering.

b. Select **OK**.

3. Return to the Extension Node Database Information menu.
4. Add information to the SDR for extension node adapters:

SELECT **Enter Extension Node Adapter Information**

- The Enter Extension Node Adapter Information menu appears.

a. Enter values for the following extension node adapter attributes:

Network Address	The IP network address for the extension node adapter.

Network Netmask	The network mask for IP addresses on the attached network on which the extension node adapter resides.
Reconfigure the extension node?	**yes** or **no**. **yes** notifies the SNMP Agent on the extension node that extension node information has been added or changed. This notification causes the SNMP Agent on the extension node to request configuration information from the SP SNMP Manager on the control workstation.
Node Number	The node number that corresponds to the valid unused switch port assigned to the extension node. *Required*. See *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment* for information on switch node numbering.

b. Select **OK**.

From the Command Line

1. Use the **endefnode** command to add extension node information to the SDR.
2. Use the **endefadapter** command to add extension node adapter information to the SDR.

See the book *PSSP: Command and Technical Reference* for information on these commands.

Changing Extension Nodes and Extension Node Adapters

You can change information for extension nodes and extension node adapters that you've already defined in the SDR by using either the SMIT or the command line.

Whichever way you choose, after changing the information in the SDR, the extension node has to be reconfigured to make the changes become effective. Which steps to perform and in which sequence, depends on which attributes you plan to change. Consider each step in the following procedure and perform it if it applies to your circumstances:

1. IBM suggests you run the **Efence** command to fence the extension node before making any changes.
2. If you intend to change the network address (IP address) of the extension node adapter, you have to remove the current interface (or IP address) on the extension node adapter before you reconfigure the extension node adapter. Run the following commands on the extension node adapter:

   ```
   ifconfig gt0x0 down
   ifconfig gt0x0 delete
   ```

   where `x` is the slot number, in hexadecimal notation, of the extension node adapter.
3. If you choose to use SMIT and you specify **yes** for the option `Reconfigure the extension node`, it will reconfigure the node as part of changing the SDR

information. You can also choose to reconfigure it later. Decide whether to use SMIT or the command line and make your change.

4. If you did not have SMIT reconfigure the extension node or if you used the command line, use the instructions in “Reconfiguring Extension Nodes and Extension Node Adapters” on page 286 to do it now.

5. If the switch automatic unfence feature is enabled and the extension node is in the autojoin state, the node should automatically join the switch after it tests ready. To bring the extension node on the switch if the automatic unfence feature has been disabled or if the extension node is not in the autojoin state, run the **Eunfence** command after the extension node has been reconfigured.

6. Verify that the changes you specified have been made. See “Listing Extension Node and Extension Node Adapter Information” on page 287.

From SMIT

1. Access the Extension Node Database Information menu:

   ENTER **smit enter_extdata**

   - The Extension Node Database Information menu appears.

2. Change information in the SDR for extension nodes:

   SELECT **Enter Extension Node Information**

   - The Enter Extension Node Information menu appears.

   a. Enter new values for the extension node attributes you wish to change. (Refer to “Adding Extension Nodes and Extension Node Adapters” on page 281 for a description of these values.)

      Note: You cannot change the node number of the extension node. You must remove the extension node number from the SDR (by using the SMIT menus described in “Removing Extension Nodes and Extension Node Adapters” on page 285 or the **enrmnode** command) and add it back with a new node number (by using the SMIT menus described in “Adding Extension Nodes and Extension Node Adapters” on page 281 or the **endefnode** command).

   b. Select **OK**.

3. Return to the Extension Node Database Information menu.

4. Change information in the SDR for extension node adapters:

   SELECT **Enter Extension Node Adapter Information**

   - The Enter Extension Node Adapter Information menu appears.

   a. Enter new values for the extension node adapter attributes you wish to change. (See “Adding Extension Nodes and Extension Node Adapters” on page 281 for a description of these values.)

      Note: You cannot change the node number of the extension node. You must remove the extension node number from the SDR (by using the SMIT menus described in “Removing Extension Nodes and Extension Node Adapters” on page 285 or the **enrmnode** command) and add it back with a new node number (by using the SMIT menus described in “Adding Extension Nodes and Extension Node Adapters” on page 281 or the **endefnode** command).

   b. Select **OK**

From the Command Line

1. Use the **endefnode** command with the appropriate flags and operand to change the definition for an extension node in the SDR.
2. Use the **endefadapter** command with the appropriate flags and operand to change the definition for an extension node adapter in the SDR.

See the book *PSSP: Command and Technical Reference* for details on these commands.

Removing Extension Nodes and Extension Node Adapters

You can remove information for extension nodes and extension node adapters from the SDR by using either the SMIT or command line interface.

Note: You must **reset** the extension node (using either **enadmin -a reset** or **enrmnode -r**) *before* removing the extension node adapter or extension node.

From SMIT

1. Access the Delete Database Information menu:

   ENTER **smit delete_data**

   - The Delete Database Information menu appears.

2. Delete extension node information:

   SELECT **Delete Extension Node Information**

   - The Delete Extension Node Information menu appears.

   a. Enter values to delete extension node information:

Reset the Extension Node?	**yes** or **no**. **yes** notifies the SNMP Agent on the extension node to remove the node from the switch network.
Node Number	The number ID assigned to the extension node.

   b. Select **OK**.

3. Return to the Delete Database Information menu.
4. Delete extension node adapter information:

   SELECT **Delete Extension Node Adapter Information**

   - The Delete Extension Node Adapter Information menu appears.

   a. Enter value to delete extension node adapter information:

Node Number	The number ID assigned to the extension node.

   b. Select **OK**.

From the Command Line

1. Use the **enrmnode** command to remove extension node information from the SDR.
2. Use the **enrmadapter** command to remove extension node adapter information from the SDR.

See the book *PSSP: Command and Technical Reference* for information on these commands.

Reconfiguring Extension Nodes and Extension Node Adapters

After extension node and extension node adapter information has been changed in the SDR, the extension node SNMP Agent must be notified.

If the switch automatic unfence feature is enabled and the extension node is in the autojoin state, the node should automatically join the switch after it tests ready. To bring the extension node on the switch if the automatic unfence feature has been disabled or if the extension node is not in the autojoin state, run the **Eunfence** command after the extension node has been reconfigured.

From SMIT

Use the SMIT menus for adding or changing extension node information as described in "Adding Extension Nodes and Extension Node Adapters" on page 281 and "Changing Extension Nodes and Extension Node Adapters" on page 283. Specify **yes** for **Reconfigure the extension node?**.

SMIT menus are also provided that invoke the **enadmin** command.

1. Access the RS/6000 Cluster Management menu:

   ENTER **smit cluster_mgmt**

   - The RS/6000 Cluster Management menu appears.

2. Run the **enadmin** command:

   SELECT **Run enadmin Command**

   - The Extension Node Management menu appears.

   a. Enter values to manage the extension node:

Action to be performed on the extension node	**reconfigure** or **reset**.
Node Number	The number ID assigned to the extension node.

   b. Select **OK**.

From the Command Line

1. Use the **endefnode -r** command to reconfigure extension nodes.
2. Use the **endefadapter -r** command to reconfigure extension node adapters.
3. As an alternative to using **endefnode -r** and **endefadapter -r**, you can use the **enadmin** command to notify the SNMP Agent managing the extension node to

request updated configuration information from the SP SNMP Manager (the **spmgrd** daemon) running on the control workstation.

See the book *PSSP: Command and Technical Reference* for details on these commands.

For more general information on reconfiguring extension nodes and extension node adapters, see "Transferring Extension Node Configuration Information" on page 281.

Resetting Extension Nodes

Resetting an extension node notifies the SNMP Agent managing the extension node to remove the extension node from the switch network.

Note: You must **reset** the extension node (using either **enadmin -a reset** or **enrmnode -r**) *before* removing the extension node adapter or extension node.

From SMIT

Use the SMIT menus for removing extension node information as described in "Removing Extension Nodes and Extension Node Adapters" on page 285. Specify **yes** for **Reset the extension node?**.

You can also use the SMIT menus for running the **enadmin** command as described in "Reconfiguring Extension Nodes and Extension Node Adapters" on page 286. Specify **reset** for **Action to be performed on the extension node**.

From the Command Line

Use the **enrmnode -r** or **enadmin -a reset** commands to notify the SNMP Agent managing the extension node to remove the node from the switch network.

See the book *PSSP: Command and Technical Reference* for details on these commands.

Listing Extension Node and Extension Node Adapter Information

You can display information for extension nodes and extension node adapters from the SDR by using either the SMIT or command line interface or through the SP Hardware Perspective.

From SMIT

1. Access the List Database Information menu:

   ENTER **smit list_data**

   - The List Database Information menu appears.

2. List extension node database information:

   SELECT **List Extension Node Database Information**

   - The List Extension Node Database Information menu appears.

   a. Enter values to list extension node database information:

Allow Nodes Outside Current System Partition? yes or **no**.

Node Type	**all** specifies the query for both standard and dependent nodes. **standard** or **dependent** restricts the query to those types of nodes.
Node Group	The name of the node group to which the query is restricted. Only the nodes in the named node group will be queried. *Not supported for extension nodes.*
Sort Attribute	The name of a valid attribute of one of the node classes in the SDR. (See "System Data Repository Classes and Attributes" on page 545 for more information.) Listing output will be sorted by this attribute.
Query Attribute	The name and value (specified as *attribute*==*value*) of a valid attribute of one of the node classes in the SDR. (See "System Data Repository Classes and Attributes" on page 545 for more information.) Node information will be listed by the specified attribute. (The default is **node_number**, in which case information is listed by node number.)
Output Attribute	The attributes you want displayed.

b. Select **OK**.

3. Return to the List Database Information menu.
4. List extension node adapter database information:

SELECT List Extension Node Adapters Database Information

- The List Extension Node Adapters Database Information menu appears.

a. Enter values to list extension node adapter information:

Allow Adapters Outside Current System Partition? yes or **no**.

Node Type	**all** specifies the query for both standard and dependent nodes. **standard** or **dependent** restricts the query to those types of nodes.
Query Attribute	The name and value (specified as *attribute*==*value*) of a valid attribute of one of the node classes in the SDR. (See "System Data Repository Classes and Attributes" on page 545 for more information.) Node information will be listed by the specified attribute. (The default is **node_number**, in which case information is listed by node number.)
Output Attribute	The attributes you want displayed.

b. Select **OK**.

From the Command Line

1. Use the **splstnodes** command to list information for standard and extension nodes.
2. Use the **splstadapters** command to list information for standard node adapters and extension node adapters.

See the book *PSSP: Command and Technical Reference* for information on these commands.

From the Hardware Perspective

Note that in Perspectives, extension nodes are also referred to as IP nodes or dependent nodes. In the Hardware Perspective, you can:

- View attributes of extension nodes in the properties notebooks by selecting the node and then selecting the notebook tool bar icon.
- Monitor Switch Responds

See the online help for more details on setting up monitoring.

Monitoring and Controlling the SP System

Chapter 19. Using SP Perspectives

SP Perspectives is a set of applications, each with a graphical user interface (GUI) that enables you to perform SP system monitoring and management tasks by letting you directly manipulate icons that represent system objects. This chapter is an overview for using SP Perspectives, covering the following topics:

- Getting started
- Understanding the SP Perspectives interface
- Accessing help for SP Perspectives
- What you can do with SP Perspectives that was previously done using the System Monitor GUI

Specific instruction for performing tasks using the various SP Perspectives interfaces is available through an extensive online help system. It is not repeated in this book. To look at the online help, see "Accessing Help" on page 304.

In general, after starting SP Perspectives, you simply select an SP system object (an SP system managed resource such as a frame, node, or switch) by clicking on it with the mouse, then select an action to perform on that object from the menu or tool bar. Use this pattern, of selecting an object then selecting an action, to accomplish numerous system management tasks with SP Perspectives. Many actions are common to each Perspective, such as: view and modify properties, open TTY, and run command. Table 11 lists the high-level tasks, some common and some unique, that can be performed by each Perspective. The online help, which explains how to perform each of the tasks, can be started from the SP Perspectives Launch Pad.

Table 11 (Page 1 of 2). Perspective High-Level Tasks

This Perspective:	Enables you to perform these high-level tasks:
Hardware Perspective	• Select a hardware object • Set the current system partition • View hardware attributes • Monitor hardware objects • Control system partitions • Control nodes • Control node groups • Control Netfinity nodes • Control frames and switches • Control SP Expansion I/O Units
Event Perspective	• Create an event definition or condition • View or modify an event definition or condition • Register or unregister event definitions or conditions • Set notification of events or conditions • Delete event definitions or conditions

Table 11 (Page 2 of 2). Perspective High-Level Tasks

VSD Perspective	• Create or Define IBM VSDs • Designate a node as an IBM VSD node • Create or Define IBM HSDs • Control IBM RVSD Subsystem • Configure IBM VSDs and IBM HSDs • Change IBM VSDs State • Unconfigure IBM VSDs and IBM HSDs • Undefine IBM VSDs • Remove IBM VSDs • Undefine IBM HSDs • Remove IBM HSDs • Remove IBM VSD Node Designation • Display IBM VSD Diagnostics • Change Owner and Group of IBM VSDs
System Partitioning Aid Perspective	• Define a new system partition • Add nodes to a system partition • Verify the system partition configuration • Generate and save a new system partition • Delete a system partition
Performance Monitoring Perspective	• View your system's monitoring hierarchy • Display performance data • Configure your system's hierarchy • Start and stop performance data collection • Start and stop performance data archiving
Perspectives Launch Pad	• Provides access to system management tools such as SMIT • Provides a launch point for all Perspectives • You can add applications to the launch pad

SPMON GUI Equivalency: If you previously used the System Monitor GUI to perform hardware administrative tasks, you can now use the Hardware Perspective to perform the equivalent functions. See “Performing Common Administration Tasks with SP Perspectives Previously Performed Using System Monitor GUI” on page 305 for more information.

Getting Started

This section discusses authorization for using SP Perspectives and how to start SP Perspectives.

Authorizing Users for SP Perspectives

There is no special authorization directly associated with using the SP Perspectives applications, but keep in mind that each SP Perspectives application has an interface to SP information and functions. Before you can see particular information or perform certain tasks using SP Perspectives, you must be authorized to:

- Access the particular information that you want Perspectives to display.
- Use the AIX and SP commands and services that perform the actions you want to initiate using Perspectives.

SP Perspectives do require that you have direct authorization for the particular objects and actions that have security restrictions, before you can access them. Who can authorize users, which users are to be authorized to what, and how to authorize users all depend on the security policy implemented by your organization on your SP system. For more information, see Chapter 2, “Security Features of the SP System” on page 13.

Table 12 lists each Perspective and the authorization required to have the full function provided by that Perspective. See the Perspective Online help "Understanding SP Perspectives Security" for a complete list of authorizations required for the function of each Perspective.

Table 12 (Page 1 of 3). Authorization required for each Perspective

Access Required	**DCE**	**Compat**
Event Perspective		
SDR Write	User's DCE principal must be a member of the **sdr-write and sdr-system-class-write** or of the **sdr-admin and sdr-system-class-admin** DCE groups.	User must have **root** privilege.
Event Management	User's DCE principal must be a member of the **haem-users** DCE group.	None required.
Problem Management	User's DCE principal must be a member of the **sysctl-pman** DCE group.	User's Kerberos V4 principal must be configured in the **/etc/sysctl.pman.acl** file on the control workstation and nodes.
Hardware Perspective		
SDR Write	User's DCE principal must be a member of the **sdr-write and sdr-system-class-write** or of the **sdr-admin and sdr-system-class-admin** DCE groups.	User must have **root** privilege.
Hardmon	User's DCE principal must be a member of the **hm-monitor and hm-control** DCE groups.	User's Kerberos V4 principal must be configured in the **/spdata/sys1/spmon/hmacls** file.
Event Management	User's DCE principal must be a member of the **haem-users** DCE group.	None required.

Table 12 (Page 2 of 3). Authorization required for each Perspective

Access Required	DCE	Compat
Efence, Estart	User's DCE principal must be a member of the **sysctl-cwsroot** DCE group.	One of the following: • User must have **root** privilege. • User's Kerberos V4 principal must be included in the **/etc/sysctl.rootcmds.acl** file.
cshutdown, cstartup	One of the following: • User must have **root** privilege. • User must be a member of the **shutdown** AIX group. • User must be a member of the **cshut** AIX group **and** the user's DCE principal must be a member of the **hm-control** DCE group.	One of the following: • User must have **root** privilege. • User must be a member of the **shutdown** AIX group. • User must be a member of the **cshut** AIX group **and** the user's Kerberos V4 principal must be configured in the **/spdata/sys1/spmon/hmacls** file.
Performance Monitor Perspective		
SDR Write	The Performance Monitoring Perspective does not run in a DCE environment.	User must have **root** privilege.
System Partitioning Aid Perspective		
	User must have **root** privilege on the control workstation to save a configuration file to the **/spdata/sys1/syspar_configs** file.	User must have **root** privilege on the control workstation to save a configuration file to the **/spdata/sys1/syspar_configs** file.
IBM Virtual Shared Disk Perspective		
SDR Write	User's DCE principal must be a member of the **sdr-write and sdr-system-class-write** or of the **sdr-admin and sdr-system-class-admin** DCE groups.	User must have **root** privilege.
root privilege	There is some function in the IBM VSD Perspective that requires root privilege regardless of DCE.	There is some function in the IBM VSD Perspective that requires root privilege.
Hardmon	User's DCE principal must be a member of the **hm-monitor and hm-control** DCE groups.	User's Kerberos V4 principal must be configured in the **/spdata/sys1/spmon/hmacls** file.
Event Management	User's DCE principal must be a member of the **haem-users** DCE group.	None required.
VSD	User's DCE principal must be a member of the **sysctl-vsd** DCE group.	User's Kerberos V4 principal must be included in the **/etc/sysctl.vsd.acl** file.

Table 12 (Page 3 of 3). Authorization required for each Perspective

Access Required	**DCE**	**Compat**
Efence, Estart	User's DCE principal must be a member of the **sysctl-cwsroot** DCE group.	One of the following: • User must have **root** privilege. • User's Kerberos V4 principal must be included in the **/etc/sysctl.rootcmds.acl** file.
cshutdown, cstartup	One of the following: • User must have **root** privilege. • User must be a member of the **shutdown** AIX group. • User must be a member of the **cshut** AIX group **and** the user's DCE principal must be a member of the **hm-control** DCE group.	One of the following: • User must have **root** privilege. • User must be a member of the **shutdown** AIX group. • User must be a member of the **cshut** AIX group **and** the user's Kerberos V4 principal must be configured in the **/spdata/sys1/spmon/hmacls** file.

Starting SP Perspectives

There are several ways of starting an SP Perspectives application. You can:

1. Use the SP Perspectives Launch Pad.
2. Start any of them directly.
3. Use the Common Desktop Environment (CDE).

Whichever way you choose, first do the following:

1. Export your display
2. If not already there, place **/usr/lpp/ssp/bin** in your PATH. Otherwise, you must prefix each command with **/usr/lpp/ssp/bin/** when you type it.

To start SP Perspectives and use the Launch Pad running as a background process, do the following:

1. Run the command **perspectives &** to open the SP Perspectives Launch Pad window.

   System management applications provided by SP Perspectives appear as icons in the Launch Pad window. For more information on the Launch Pad, see "The Launch Pad" on page 298.

2. To start an SP Perspectives application, use either of the following ways:
   - Double-click on the icon for the application you want to run.
   - Or do the following:
     a. Click on the icon for the application you want to run.
     b. Click **Actions** on the menu bar.
     c. Click on **Launch**.

Initially an hourglass icon appears, followed by the SP Perspectives splash screen, to let you know processing is occurring. Then, the application window (also referred to as the "Perspective") appears.

To start SP Perspectives applications directly, running as background processes without using the Launch Pad, enter any of the following at the command line:

sphardware &	The Hardware Perspective used to manage, control, and monitor hardware
spevent &	The Event Perspective used to set up and manage events
spvsd &	The IBM Virtual Shared Disk Perspective used to create, manage, and monitor virtual shared disks
spsyspar &	The System Partitioning Aid Perspective used to define system partitions
spperfmon &	The Performance Monitor Perspective used to set up and configure performance monitoring

To start SP Perspectives applications using DCE, double-click on the SP Perspectives icon in the CDE Application Manager window.

Understanding the SP Perspectives Interface

SP Perspectives consists of the following graphical elements:

- Launch Pad
- Perspectives Application Windows (also known as "Perspectives")
- Dialog boxes
- Notebooks
- Message boxes

The Launch Pad

The Launch Pad starts applications associated with managing an SP system. It also provides options for customizing the appearance of the Launch Pad.

System management applications provided by SP Perspectives appear as icons on the Launch Pad. Other system management tools, such as SMIT and the SP Resource Center are also accessible from the Launch Pad. In addition, you can add your own applications to the Launch Pad. For descriptions of the applications provided by default, select Options → Show Application Details.

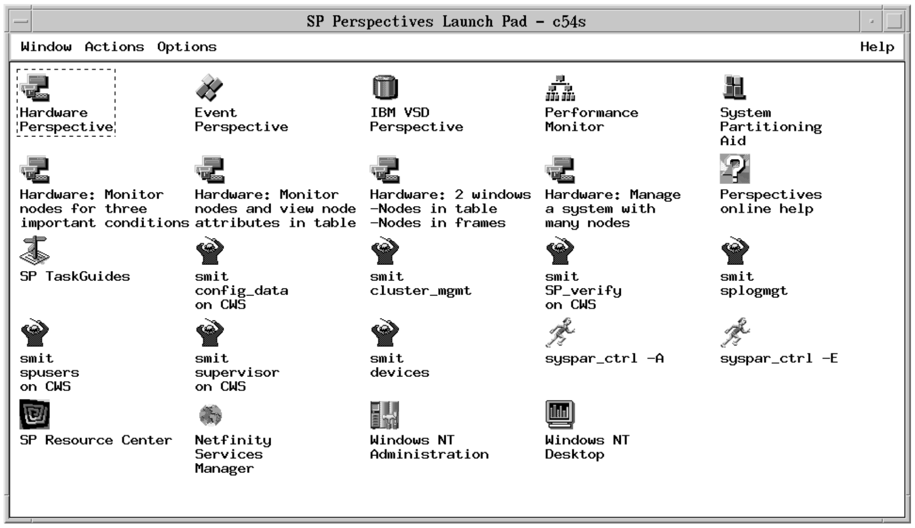


Figure 30. The SP Perspectives Launch Pad

For detailed information on the elements of the Launch Pad, see the Perspectives online help information.

Perspectives Applications

All of the Perspectives applications are available on the launch pad, some with customized profiles.

SMIT Menus

Common SMIT administration menus are selectable from the launch pad.

SP Resource Center

The SP Resource Center provides one simple interface for all softcopy SP documentation and information resources. It consists of HTML, Java, and Javascript files and works with a Web browser. The Resource Center provides access to a variety of information including publications, READMEs, Redbooks, White Papers, SP product information, as well as up-to-date service information.

To access the SP Resource Center, double click on the SP Resource Center icon and the SP Resource Center window will appear once the Web browser has launched. The left margin of this window contains navigational aids to help you find the information for which you are looking. For example, to find out information on PSSP documentation, you would select Publications. Similarly, to find out information on SP hardware or software, select Product Information.

SP TaskGuides

SP TaskGuides are a form of advanced online assistance designed to walk you through complex or infrequently performed tasks. Each TaskGuide does not simply list the required steps. It actually performs the steps for you, automating the steps to the highest degree possible and prompting you for input only when absolutely necessary. You might recognize them as *wizards*.

The following TaskGuides are available:

- Set Site Environment Information
- Add Frames

- Configure New Nodes
- Create Node Image

Netfinity Services Manager

Netfinity node administration interfaces are selectable from the launch pad.

Perspective Application Windows

The application window for each SP Perspectives application is called a "Perspective" because it provides a unique view of your SP system. The Hardware Perspective, for example, allows you to view the system as a set of hardware objects (for example, nodes, frames, switches). The Event Perspective allows you to view the system in terms of conditions of interest related to system resources.

These windows contain work areas known as *panes*. Panes contain icons representing system objects (a managed SP system resource such as a node, frame, or switch).

- To perform actions on the way objects are displayed in a pane:
  1. Click on the pane to give it focus.
  2. Select **View** from the menu bar.
  3. Select the desired action from the pull down menu. (Alternatively, some of the **View** options are available from the tool bar.)
- To perform actions on the *objects themselves*:
  1. Select one or more objects.
     - To select multiple objects that are next to each other in a pane, click on the icon of the first desired object, hold the left mouse button down, and move the cursor over the icons of other desired objects in the pane.
     - To select multiple objects that are not next to each other in a pane, hold the **Ctrl** key on your keyboard down while you click on each desired object in the pane.
  2. Select **Actions** from the menu bar.
  3. Select the desired action from the pull down menu. (Alternatively, some of the **Actions** are available from the tool bar.) Note that the choices available under the Actions menu may vary depending upon the type of objects selected.

Each Perspective consists of the same basic format as illustrated in Figure 31 on page 301.

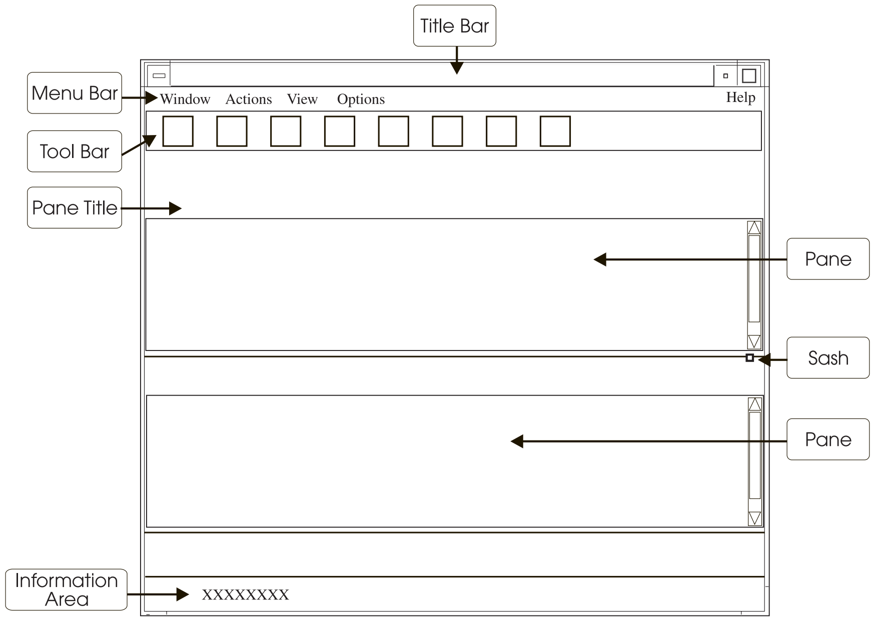
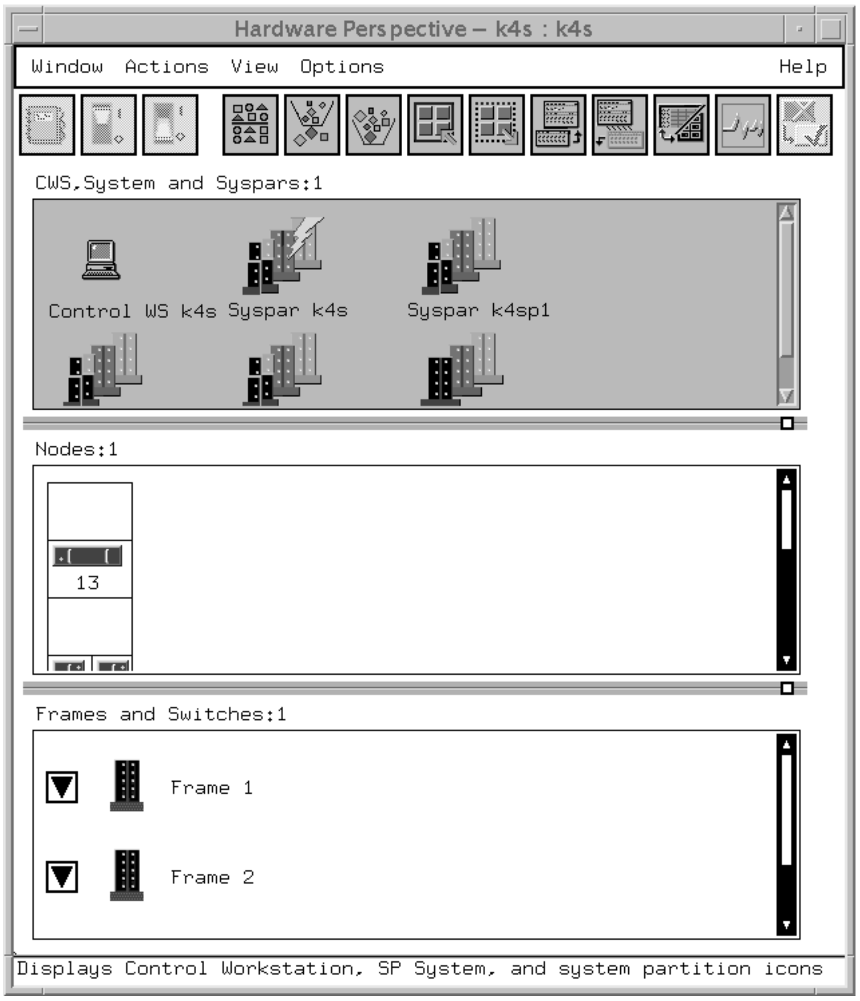


Figure 31. Elements of an SP Perspectives Window



Displays Control Workstation, SP System, and system partition icons

Figure 32. The SP Perspectives Hardware Perspective

For detailed information on the elements of an application window, see the Perspectives online help information.

Dialog Boxes

When you use an SP Perspectives application window to perform certain actions, a dialog appears. The dialog box solicits or displays additional information needed to complete the action. The specific information or actions contained in the dialog box depend on the application.

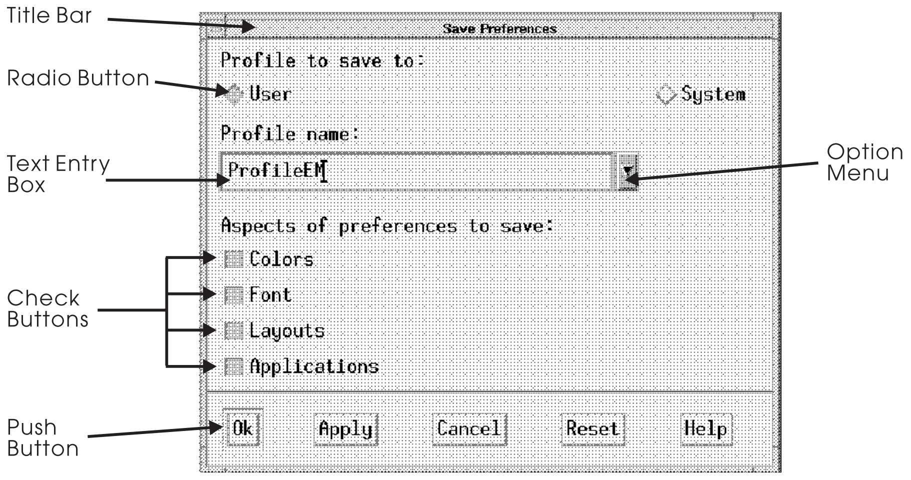


Figure 33. An SP Perspectives Dialog Box

For detailed information on the elements of a dialog box, see the Perspectives online help information.

Notebooks

A notebook lets you view or alter object properties. Each page in the notebook contains property information (defining or operational characteristics) about system objects. Similar properties are grouped on the same page and identified by tabs. The specific property information contained on a notebook page depends on the object.

Notebooks typically contain the following elements:

- The title bar, which displays the action (view, modify), the object name or type, and optionally, the system partition name.
- Text entry boxes for entering text information for object attributes that can be modified.
- Static text entry fields for displaying object attribute information that cannot be modified (view only).
- Check buttons for selecting one or more choices from a list of options that are not mutually exclusive.
- Radio buttons for making a single choice from a list of mutually exclusive options.
- Option menus for entering information and selecting a single choice from a list of mutually exclusive options.
- Buttons for selecting an action:

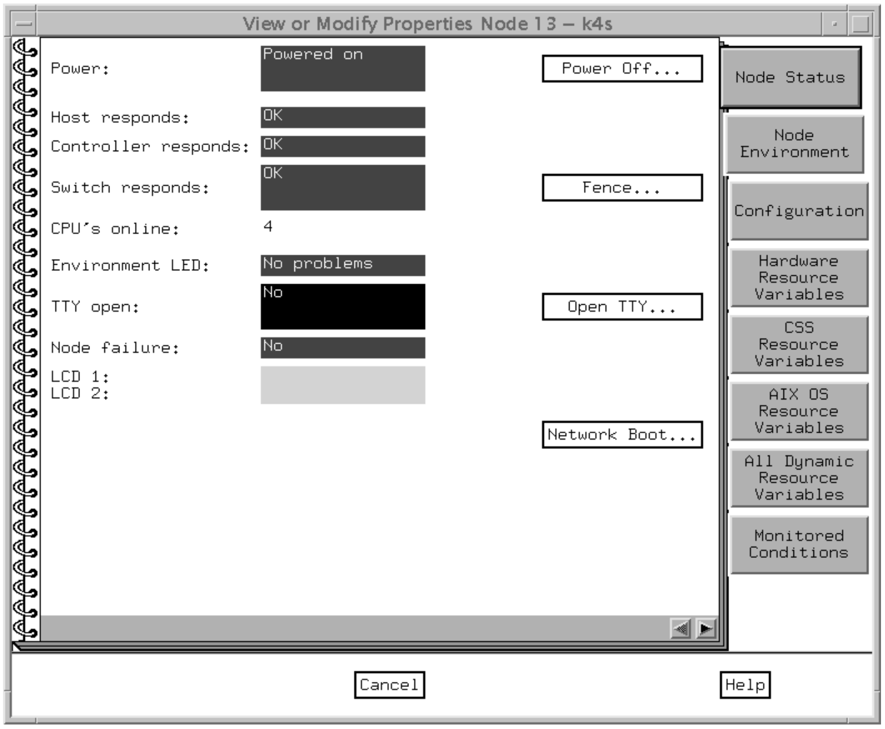
– OK - updates attribute information and closes the notebook.

– Apply - updates attribute information and leaves the notebook open.

– Cancel - cancels any changes made to the original values and closes the notebook.

– Reset - resets any changes made to the original values and leaves the notebook open.

– Help - displays general help about using notebooks.



View or Modify Properties Node 13 – k4s

Power: Powered on

Host responds: OK

Controller responds: OK

Switch responds: OK

CPU's online: 4

Environment LED: No problems

TTY open: No

Node failure: No

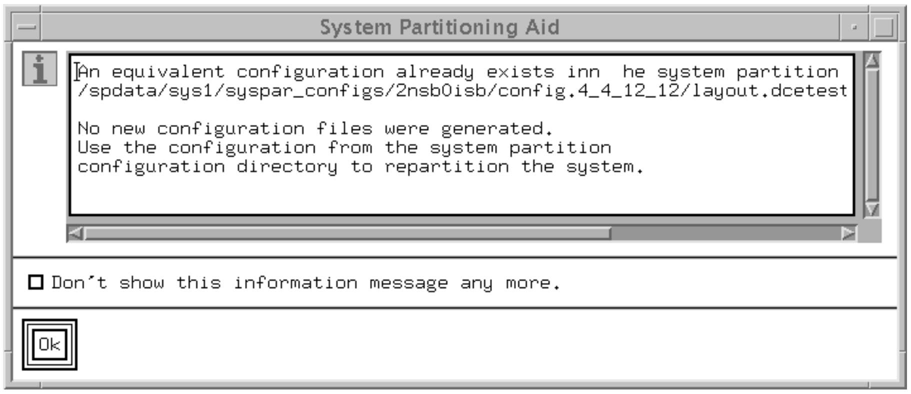
LCD 1:
LCD 2:

Figure 34. An SP Perspectives Notebook

Message Boxes

A message box is a type of dialog box used to convey a message to you. Following is a list of the message types:

- Informational
- Warning
- Error



```
An equivalent configuration already exists inn  he system partition
/spdata/sys1/syspar_configs/2nsb0isb/config.4_4_12_12/layout.dcetest

No new configuration files were generated.
Use the configuration from the system partition
configuration directory to repartition the system.
```

☐ Don't show this information message any more.

Figure 35. An SP Perspectives Message Box

For detailed information on the elements of a message box, see the Perspectives online help information.

Accessing Help

| You can open the online help directly when you double-click on the Perspectives
| Online Help object in the Perspectives Launch Pad. If you prefer, you can use the
| following command:

```
/usr/dt/bin/dthelpview -helpVolume /usr/lpp/ssp/perspectives/help/en_US/pgui.sdl
```

| When you are already in Perspectives, you can access help by using any of the
| following interfaces:

- Menu bar **Help** button
- Bubble-up text
- Information area
- Dialog box, notebook, and message box **Help** buttons

The Menu Bar

The menu bar **Help** contains items that provide information about windows, actions (tasks), and objects. To display the menu items, click on **Help** in the upper right hand corner of the menu bar.

- **Overview** activates a stand-alone help volume that contains overview and task-oriented information for SP Perspectives.
- **Contents** displays a list of help topics for SP Perspectives.
- **Tasks** accesses task-oriented help information for the Perspective that you are in when you click on **Tasks**.
- **Using Help** provides information on how to access help for SP Perspectives.
- **About SP Perspectives** displays the name and version of the application.
- **Give Feedback to IBM** provides information about how to contact the SP Perspectives team with your comments.

The Bubble-Up Text

The bubble-up text is present for all icons on the tool bar and provides a brief description of the function of that icon. Bubble-up text is also available when the mouse is placed over the title and monitoring label above a pane. This text describes pane related information such as the number of objects in the pane, number of objects filtered, the label used for the objects, and what objects are being monitored for specific conditions.

The Information Area

The Information Area is present at the bottom of application windows and displays information about the object or area at the current cursor location. You can toggle this display on and off from the **Options** menu.

The Dialog Box, Notebook, and Message Box Help Buttons

The dialog box and notebook **Help** buttons display information about the purpose of items in the dialog box or notebook. The message box provides an **Error Stack** button which displays extended information on the contents of the message and provides a way to view internal diagnostics information.

Performing Common Administration Tasks with SP Perspectives Previously Performed Using System Monitor GUI

If you previously used the System Monitor GUI to perform hardware administrative tasks, you now can use the Hardware Perspective to perform the same functions. Table 13 lists the System Monitor GUI function and the corresponding Hardware Perspective function. **Note that this table does not provide detailed instructions on performing these tasks using the Hardware Perspective. For more detailed information, see the Hardware Perspective online help.**

Table 13 (Page 1 of 4). System Monitor to Perspectives Cross Reference

System Monitor GUI function	Equivalent function in Perspectives
All node summaries	To monitor the conditions of nodes: 1. Ensure that the Nodes pane is displayed and is the current pane. You may need to add a Nodes pane first. Then, click in the Nodes pane to make it the current pane. 2. Select View → Set Monitoring from the menu bar or click on the Monitoring icon on the tool bar. 3. Select one or more conditions to monitor. The most common conditions you may want to monitor include hostResponds, switchResponds, and nodePowerLED The most commonly used all node summaries are available for monitoring using Perspectives. Note that the 3DigitDisplay previously available using spmon, can be seen by selecting Actions → LCD/LED Display. The Nodes pane must be the active pane in the window. Note that you can add multiple Nodes panes and monitor a different condition in each pane or you can monitor multiple conditions inside one pane.

Table 13 (Page 2 of 4). System Monitor to Perspectives Cross Reference

Node Front menu	Variables and controls displayed on the Node Front menu now appear on the Node Status page. 1. Ensure that the Nodes pane is displayed and is the current pane. You may need to add a Nodes pane first. Then, click in the Nodes pane to make it the current pane and select a node for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Node Status page. This is the default page.
Node Environment Layout	Variables and controls displayed on the Node Environment Layout now appear on the Node Environment page. To display this information: 1. Ensure that the Nodes pane is displayed and is the current pane. You may need to add a Nodes pane first. Then, click in the Nodes pane to make it the current pane and select a node for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Node Environment page.
Node Detail Layout	Variables displayed on the Node Detail Layout now appear on the Node Environment page except for the following: • type (node supervisor card type) and codeVersion (node supervisor code version) are shown on the Configuration page • powerLED (Power) and envLED (Environment LED) are shown on the Node Status page. To display this information: 1. Ensure that the Nodes pane is displayed and is the current pane. You might need to add a Nodes pane first. Then, click in the Nodes pane to make it the current pane and select a node for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select either the Node Environment page, the Configuration page, or the Node Status page.
Frame Environment Layout	Variables displayed on the Frame Environment Layout now appear on the Frame Status page in the Frame notebook. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a frame for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Frame Status page in the Frame notebook.

Table 13 (Page 3 of 4). System Monitor to Perspectives Cross Reference

Frame Detail Layout	Variables displayed on the Frame Detail Layout now appear on the Frame Configuration page in the Frame notebook. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a frame for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Frame Configuration page in the Frame notebook.
Switch Environment Layout	Variables displayed on the Switch Environment Layout now appear on the Switch Status page in the Switch notebook. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a switch for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Switch Status page in the Switch notebook.
Switch Front menu	Variables and controls displayed on the Switch Front menu now appear on the Switch Status page in the Switch notebook. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a switch for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Switch Status page in the Switch notebook.
Switch Detail Layout	Variables displayed on the Switch Detail Layout now appear on the Switch Status page in the Switch notebook except for type and codeVersion which are on the Configuration notebook page. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a switch for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Switch Status page in the Switch notebook.

Table 13 (Page 4 of 4). System Monitor to Perspectives Cross Reference

Switch Diagnostics Layout	Variables displayed on the Switch Diagnostics Layout now appear on the Switch Status page of the Switch notebook. To display this information: 1. Ensure that the Frames and Switches pane is displayed and is the current pane. You may need to add a Frames and Switches pane first. Then click in the pane to make it the current pane and select a switch for which to view properties. 2. Select Actions → View or Modify Properties from the menu bar or just click on the Notebook icon. 3. Select the Switch Status page in the Switch notebook.
Global Controls	Information displayed through the spmon Global Controls function is available: 1. Select the nodes in the Nodes pane for which you want information 2. Select Actions from the menu bar. The following actions are available: • Power Off, Reset, or Shutdown - to perform a power off with setting certain options such as a straight power off or reset, a shutdown or cshutdown, or fence or fence with autojoin. • Power On or Cluster Power On - to power on one or more nodes with the options for performing a straight power on or a cstartup. • Change Key Switch - change key switch position on nodes that have a key switch. • Fence or Unfence - fence or unfence nodes. • Open TTY - to open TTY windows to selected nodes. • Run Command - run a command on selected nodes. • Network Boot - network boot a node
Topology	Not currently supported in Perspectives.

Chapter 20. Using the SP System Monitor

The SP System Monitor allows authorized operators and administrators to operate and monitor the system hardware. It allows authorized users to control and monitor the status of the frames, nodes, and switches of the SP system. It is a client-server application. The server, the hardmon daemon, executes only on the SP control workstation and controls the SP supervisor subsystem through the device special files for the RS-232 connections to each frame supervisor. You can use the SP Hardware Perspective graphical user interface or you can use the line commands to perform the tasks. For information on the SP Perspectives GUI, see Chapter 19, "Using SP Perspectives" on page 293. If you are familiar with the pre-PSSP 3.1 system monitor GUI, you might be interested in "Performing Common Administration Tasks with SP Perspectives Previously Performed Using System Monitor GUI" on page 305.

The SP System Monitor is made up of the following parts:

Hardware Monitor
A set of commands and a daemon used to monitor and control the SP hardware platform.

Command interface
| The **spmon**, **hmadm**, **hmdceobj**, **hmmon**, **hmcmds**, **s1term**, and **nodecond** commands with their flags and parameters, provide a way to monitor and control the system at an individual system partition level or at a global (all system partitions) level. These can be used from an ASCII terminal, such as those used on a dial-up line, from scripts, or from another terminal.

Logging daemon
The **splogd** logging daemon logs SP hardware state changes, reports SP hardware errors, and provides a state change alert.

This chapter provides conceptual information and procedures for configuring and using the SP System Monitor. Figure 36 on page 310 presents a functional overview of the SP System Monitor.

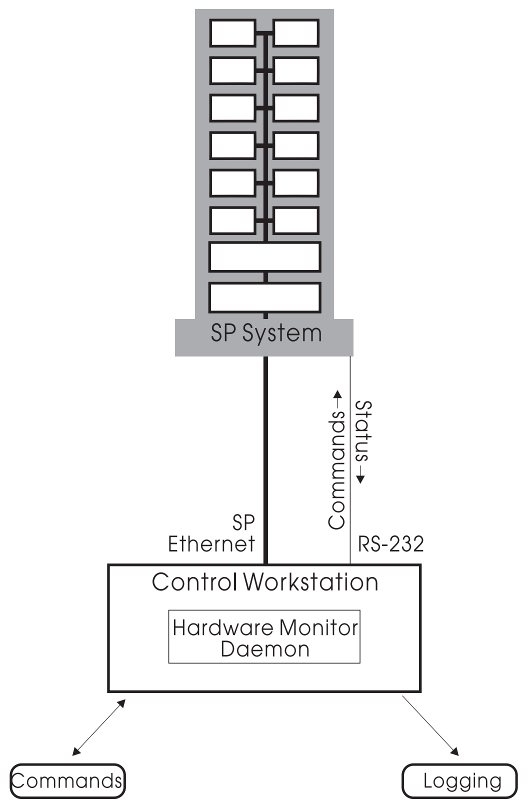


Figure 36. The SP System Monitor

Understanding the Hardware Monitor

The Hardware Monitor consists of a daemon, named **hardmon**, and a set of client commands. The daemon executes on the control workstation and, using the RS-232 lines to each frame, polls the frames for the state of the hardware within the frame. The daemon also sends hardware-level commands to each frame to change the state of the hardware within the frame in some way. The client commands, **spmon** and **hmmon**, interact with the daemon to obtain the current or changing state of the hardware. The client commands, **spmon** and **hmcmds**, also interact with the daemon to change the state of (that is, control) the hardware. The **splogd** logging daemon is also a client of the hardware monitor for logging purposes.

The **hardmon** daemon reports variables representing the state of a frame, node, SP Expansion I/O Unit, and switch hardware. These state variables are made available through the **spmon** and **hmmon** client commands. You can find a list of these variables with descriptions by using the Event Perspective GUI. This list provides variable names, display attributes and descriptions for all variables available in the SP System Monitor. The **hmmon** command, with the appropriate flag, also provides a list of variable names and descriptions. You will see these variable names in the SP System Monitor log. They also serve as parameters to the **spmon** and **hmmon** commands.

To diagnose system monitor problems including SP-attached server problems involving the **hardmon** daemon, refer to the book *PSSP: Diagnosis Guide*.

Frame Hardware State

The **hardmon** daemon reports the following variables so you can *monitor* the frame hardware status:

- Switch failure
- Power LEDs
- Environment LEDs
- Temperature
- Voltage
- State of the power supply

The **hardmon** daemon allows the authorized administrator to *control* the frame hardware state. This information includes:

- Power on/off

Note: There is no frame hardware state associated with an SP-attached server because it has no frame supervisor with which to communicate.

Node Hardware State

The **hardmon** daemon reports the following variables so you can *monitor* the node hardware status:

- Three-digit display
- Power and Environment LEDs
- Temperature
- Voltage
- Fan failure

Note: Some environment information, such as fan speed and voltage, is not available for a 604 High Node. Other environment information might not be available for an SP-attached server.

The **hardmon** daemon allows the authorized administrator to *control* the node hardware state. This information includes:

- Power on/off
- Key Mode Switch
- Reset button

Switch Hardware State

The **hardmon** daemon reports the following variables so you can *monitor* the switch hardware status:

- Temperature
- Voltage
- Fan failure
- Power and Environment LEDs

The **hardmon** daemon allows the authorized administrator to *control* the switch hardware state. This information includes:

- Power on/off
- Change multiplexor clock setting

Note: On SP Switch systems, you must use the **Eclock** command to change the multiplexor clock setting.

Authority

The objects defined and controlled by the SP system monitor are the following:

1. a single system object
2. frame objects
3. slot objects
4. a hardmon object (the system monitor daemon)

The system object is the initial object and is the container for frame objects and frame objects are containers for slot objects which represent node or switch processors. Monitor and control operations are performed on frame and slot objects. The hardmon object represents the administration function.

Because of this hierarchical structure, you can determine for your installation, the level of granularity to use for access to hardware objects.

With DCE Authentication

You can have potentially hundreds or thousands of objects and an access control list for each object. On the other hand, since the object structure is hierarchical you can have only the system object ACL and set principals and groups with authority to control all the hardware in the entire system.

There are three levels of hardmon authorization possible on an SP system depending on the granularity of object protection you choose to have:

1. System level
2. Frame level
3. Slot level

If you want different authorizations for different frames, you need frame objects and ACLs. If you want different authorizations on a node and switch basis, you need slot objects and ACLs.

Authorization is checked from the lowest level to the highest level. If the slot object and ACL does not exist for a node or switch, the frame object is checked. If a frame object and ACL does not exist, the system object and ACL is used to determine authorization. Every system has a system object. The ACL from a container is copied to a contained object by default when the object is created.

With DCE, the classes of authority for the SP System Monitor are the following:

1. a – Administrative authority permits a user to issue administrative commands to **hardmon**.
2. m – Monitor authority permits users to display system statistics.
3. s – S1 authority permits read and write access to the serial port of a node.

4. u – Authority to update microcode of the supervisor subsystem on the relevant object.
5. v – Virtual Front Operator Panel (VFOP) control authority permits users to display system statistics and control the hardware.

When using DCE authentication, the root id has no special privilege. A hardmon client needs credentials to be authorized to run hardmon commands. The client needs to log in to DCE as a principal who is a member of an appropriate access group, or who is granted access by some other entry in the DCE ACL files for the objects affected by any action requested. Scripts running as background clients can use the **dsrvtgt** command.

With Kerberos V4 Authentication

With Kerberos V4, the classes of authority for the SP System Monitor are the following:

1. a – Administrative authority permits a user to issue administrative commands to **hardmon**.
2. m – Monitor authority permits users to display system statistics.
3. s – S1 authority permits read and write access to a node's serial port.
4. v – Virtual Front Operator Panel (VFOP) control authority permits users to display system statistics and control the hardware.

VFOP control authority is needed for microcode updates to the supervisor subsystem.

With Kerberos V4, hardmon still uses a single **/spdata/sys1/spmon/hmacls** file on the control workstation for its access control list. The entries in this file are on a per-frame basis.

Configuring the SP System Monitor

The system administration tasks for configuring the SP System Monitor include authorizing users, which includes configuring additional hardware objects if you choose to when using DCE, and then configuring the error log.

Step 1: Authorize Users for the SP System Monitor

With DCE

During installation and configuration of PSSP with DCE, the following are created by default for the system monitor:

- The DCE groups:

  hm-admin – The group with hardmon administrator authority.
  hm-control – The group with all hardware permissions (v, s, m, and u).
  hm-monitor – A monitor-only group.
  hm-control-services – A hardware control group for SP trusted services.
  hm-monitor-services – A hardware monitor group for SP trusted services.

- A system object and ACL giving m, s, u, and v permission to the hm-control and hm-control-services groups and giving m permission to the hm-monitor and hm-monitor-services groups.

- A hardmon object and ACL with the hm-admin group and the spsec_admin groups. The hm-admin group represents administration authority for hardmon, including the ability to populate the hardmon object database and the ability to list hardmon objects. The spsec_admin group represents control authority with the ability to change the ACLs.

If you choose to have more granularity of access, do the following:

1. Do a dce_login with a principal that is both in the spsec_admin group and in the hm-admin group.
2. Populate the hardmon object database with additional objects and ACLs, according to the security policy of your organization, using the **hmdceobj** command or SMIT fastpath.

   You can add, delete, or list hardware objects. For example, you can grant system monitoring permission even to unauthenticated users, by adding two entries to the ACL for the system object:

   - An ANY_OTHER entry with the m permission.
   - An UNAUTHENTICATED entry with the m permission.

Use the **spacl** command or the **spauth_spacl** SMIT fastpath to manipulate the related DCE ACLs. See "Managing DCE ACLs for SP Trusted Services" on page 51.

With Kerberos V4

The SP System Monitor Access Control Lists (ACLs) are found in **/spdata/sys1/spmon/hmacls** on the control workstation. Edit this file if you wish to add users for your system. The **/spdata/sys1/spmon/hmacls** file is initially set up giving all levels of authority (including administrator) to the same user that is defined as the primary authentication services administrator by the **setup_authent** command (see Chapter 2, "Security Features of the SP System" on page 13 for more information). The **hardmon** principal is initially set up with monitor authority (for use by **splogd**).

The fields for each entry in the **/spdata/sys1/spmon/hmacls** file are

```
object  name  permissions
```

where:

object A frame number or hostname (where the **hardmon** daemon is running)

name A Kerberos principal name and optional instance

permissions

a	Administrative. This gives authority to control **hardmon**.
m	Monitor. This gives permission to receive state changes.
s	Serial link. This gives permission to read and write to a serial port.
v	VFOP control. This gives permission to issue commands to the hardware.

Invoke the **hmadm setacls** command after the ACL configuration file has been modified to update the hardware monitor daemon's internal ACL tables.

Refer to Chapter 2, "Security Features of the SP System" on page 13 for more information on security considerations.

Step 2: Configure the SP System Monitor Error Log

When the hardware supervisors indicate a warning or shutdown condition, the SP System Monitor writes a message using the AIX **syslog** facility and the AIX error log facility. For example, when the hardware supervisors determine that a fan has failed, the SP System Monitor writes a precise message into the log file that includes the time, node, type of error, variable name, and, in some cases, associated values.

The installation process creates the default system log file **/var/adm/SPlogs/SPdaemon.log** on the control workstation. You might want to configure your system to send the system log information to other locations. For example, you might want to send the **SPdaemon.log** messages to another workstation for convenience. You can do this using the *@hostname* parameter in the **/etc/syslog.conf** file. For more details, see the book *IBM AIX Files Reference*. The facility name for the SP System Monitor is **daemon**.

Using the Command Line Interfaces

The SP system includes command line interfaces that allow you to perform the SP System Monitor functions without using a graphical user interface. With the **spmon** and **hmmon** commands you can query the value of a state variable or monitor that variable for a change in state. With the **spmon** and **hmcmds** commands you can control the nodes, frames and switches. The **hmmon** and **hmcmds** commands provide equivalent function to the **spmon** command but provide a more compact interface than **spmon** that can be appropriate in scripts. The **spmon** command is provided for compatibility with earlier SP software releases.

By default, these commands operate at a system partition level. That is, they work only on nodes *in the current system partition*. (To determine the current partition, issue the **spget_syspar** command.)

Note: Hardware Monitor queries or commands using a wildcard character do not return an error code if nodes outside of the current system partition are specified by the wildcard. Nodes outside of the current partition are treated as if they don't exist.

Each of the commands has a **-G** flag that removes system partition boundaries, allowing the command to work on any hardware in the SP system. The **-G** option is *always* needed to monitor or control frame or switch hardware. Frames and switches are considered to be outside all system partitions.

Before using any SP System Monitor command your identity must be authenticated.
| Use the **k4init** or the **dce_login**command to log in to the SP authentication services. If your site uses an alternative to the SP authentication services, you must use authentication procedures appropriate to such an alternative. (Refer to Chapter 2, "Security Features of the SP System" on page 13 for more information on SP authentication services.)

See the book *PSSP: Command and Technical Reference* for a complete description of all SP System Monitor commands.

Chapter 21. Integrating TME 10 on the SP System

Tivoli Management Environment (TME 10) is a function that helps you to monitor SP events in a TME 10-managed environment. It allows an administrator to forward any event managed by the PSSP Event Management subsystem to the TME 10 Enterprise Console, which acts as a centralized point of control for the TME 10-managed environment. To define which events are forwarded by Event Management, you can use either the Event Management Perspective or the **pmandef** command.

Related Publications

This chapter does not provide all the necessary information for a complete and thorough understanding of TME terminology, concepts, and applications. For complete information, you should reference the following:

- *Integrating TME 10 on the RS/6000 SP*, Redbook written by the International Technical Support Organization. This Redbook document also has a section of related publications that you should reference.
- *PSSP: Installation and Migration Guide* contains information about installing the T/EC adapter.
- *PSSP: Command and Technical Reference* contains information on the syntax of the **pmandef** command.
- *PSSP: Diagnosis Guide* contains information on problem diagnosis related to TME 10.
- You should also reference Chapter 26, “The Event Management Subsystem” on page 377 for more information.

TME 10 Terminology

This chapter does not provide all the necessary information for a complete and thorough understanding of TME terminology, concepts, and applications. For complete information, you should refer to the Related Documentation section previously discussed. This section provides a brief overview of the major terms that are discussed in this chapter.

Tivoli Management Environment (TME)
The combination of the base TME 10 Framework, the distributed object databases, graphical user interface, command line interface, and all Tivoli toolkits and applications required within the enterprise that is managed by Tivoli.

TME 10 Framework
The base set of Tivoli software that is required to run any of the Tivoli management applications. The Framework provides basic system administration capabilities, and services for the management applications, including an administrator facility, scheduler facility, and notice facility. The TME 10 Framework is often referred to as the Tivoli Management Platform (TMP).

Tivoli Management Region (TMR)
The basic physical unit of Tivoli functionality. It consists of one TME server and the clients that server is managing.

Policy Regions, Policies
A policy region is a collection of TME resources that are controlled by a common set of policies or rules. Typically, policy regions define boundaries of the authority of Tivoli administrators, as well as provide a mechanism for organizing and managing system resources in a hierarchal structure.

Profiles, Profile Managers
A profile contains a collection of application-specific information. The information in a profile is specific to a particular profile type (for example, a user profile will contain user names, login ids, and so on). A profile manager contains profiles and a list of subscribers to which the profile data can be distributed. Subscribers can be managed nodes, PC managed nodes, NIS Domains, and other profile managers.

Administrators
A Tivoli administrator is a user that has been given authorization to perform management tasks in the TME. The administrator's authorization roles determine what tasks that administrator can perform against a set of resources.

Resources
A TME resource is a general term used to define systems, devices, services, and facilities in a distributed system. A managed resource can be owned by only one policy region.

TME 10 Application Extension Facility (AEF)
An interface to dynamically customize the Tivoli application by adding site-specific behavior or values to standard applications.

TME 10 Event Integration Facility (EIF)
A facility to build event adapters to map events from any application resource, or component into a format compatible with the TME 10 Enterprise Console.

TME 10 Application Developers Environment (ADE)
Programming tools for creating new custom management applications on top of the TME 10 Framework.

Understanding the TME 10 Enterprise Console

The TME 10 Enterprise Console (T/EC) is one of Tivoli's availability management applications. As a management tool, it assists in maintaining high availability of the myriad of networks, system applications, and databases found within the scope of an enterprise, and provides a centralized point of control for all critical messages stemming from these resources.

The computing resources in the distributed environment generated messages in a variety of formats. The function that captures these messages is called an event adapter. Each event adapter installed on or near the monitored computing resources is familiar with the structure of that raw data and transforms the information it receives by parsing and restructuring it before sending it to the T/EC event server in a T/EC acceptable format, a special structured format named

BAROC (Basic Representation of Object in C). BAROC is a simple event class structure that allows important elements of a message to be separated into a number of pieces of information called slots. Each event is defined as a member of a class.

A number of different types of T/EC event adapters may exist on any TCP/IP connected system, not only on TME managed nodes. Besides generating the events and sending them to the T/EC event server, the adapters also filter out extraneous information so only significant events are forwarded to the T/EC event server. This helps reduce the demand on the network and the amount of processing done by the T/EC event server when the computing resources are sending out large numbers of messages.

Defining the PSSP T/EC Adapter

The PSSP T/EC adapter is a tool that forwards events generated by the Event Manager subsystem to the TME 10 Enterprise Console. The PSSP T/EC adapter receives the PSSP events, extracts the event information, and formats it into a T/EC event notification automatically. The tool simplifies the forwarding of events, since it does not require any other program or script to parse the event strings. The adapter receives all the event information from the Event Management subsystem and formats it into T/EC events using the PSSP _EVENT classes, which are defined in the **pssp_classes.baroc file.** Using the **tecad_pssp** program allows you to subscribe events using the Event Management Perspective or the **pmandef** command and have this forwarded to T/EC.

This chapter does not provide details on how the PSSP T/EC adapter forwards events to the TME 10 Enterprise Console, how to use or install the adapter, or how to define event classes for PSSP events. For this detailed information, refer to the *Integrating TME 10 on the RS/6000 SP*, SG24-2071 Redbook.

Defining an Event and Forwarding it to the T/EC Using the Event Perspective

Using Event Management Perspective makes administering and managing the events in the SP system relatively easy. Once you start the Event Management Perspective:

SELECT Actions → Event Definitions → Create

The Event Definition window appears where you can select the parameters for the event definition.

SELECT The Response Options tab and enter the response options.

SELECT Take Actions when event occurs and enter the **tecad_pssp** command in the command window. Be sure to provide the full path for the command to supply a full path to your configuration file, if you are not using the default.

Repeat the same procedure for the **rearm** command if you wish. On the lower part, select the control workstation (Node 0) as the node where to run the command. Install the **tecad_pssp** command on all nodes, but IBM recommends that you use the control workstation as a central point for event forwarding since it is accessible by all partitions.

Defining an Event and Forwarding it to the T/EC Using the pmandef Command

Consult the *PSSP: Command and Technical Reference* for complete command syntax. A general example of this command follows:

```
pmandef -s example1
        -e "AnyResourceVariable;Any InstanceVenctor;AnyPredicate"
        -c "$AGENT_PATH/tecad_pssp -1 $CONF_PATH/tecad_pssp.cfg"
        -r "AnyRearmPredicate"
        -C "$AGENT_PATH/tecad_pssp -1 $CONF_PATH/tecad_pssp.cfg"
        -n 0
```

You should run this command from the control workstation to save installation efforts and keep the management of the system easier. This results in the flag *-n 0*, indicating that the command needs to be run on Node 0, the control workstation.

Debugging Problems with Event Generation and Reception by the T/EC

For debugging and problem diagnosis information, refer to the *IBM Parallel System Support Programs for AIX Diagnosis Guide*.

Chapter 22. Managing an SP-Controlled Netfinity Server

This chapter provides information to help you manage the SP-controlled Netfinity server. It briefly describes the tools that are available when you connect the Netfinity server with the control workstation and use the SP/Netfinity Server Consolidation component of PSSP.

SP-controlled Netfinity server support offers three levels of Netfinity server management:

- Direct power monitoring and control via SP Perspectives on the control workstation.
- Casual management using the Netfinity Services Manager Web interface, and optionally, the Web Administration for Windows NT software provided in the NT 4.0 Server resource kit or the Microsoft BackOffice product.
- Full native Netfinity hardware and Windows NT management displayed to the control workstation using the optional, separately installed Windows NT Terminal Server and Citrix MetaFrame products.

Netfinity Management Interfaces

These management interfaces are based on the Netfinity server:

- Netfinity Services Manager

  This is the primary system management software supplied by IBM with each Netfinity server. Netfinity Services Manager provides the ability to monitor and control a set of attributes on the Netfinity server. Some functions included are: alert management, critical file monitoring, predictive failure analysis, and service processor configuration. Netfinity Services Manager also enables you to manage groups of servers from a single server. It is primarily a hardware management interface. For more information see the IBM documentation provided with your Netfinity server or at the Web address http://www.pc.ibm.com/us/netfinity

- Web Administration for Microsoft Windows NT Server (Web Administration for Windows NT)

  The Web Administration for Windows NT is a Web-based NT administration interface. Through this add-on to NT (available in either the NT Resource Kit or as part of the BackOffice Server suite), you may view and modify basic NT operating system attributes. Among other things, this tool provides you with access to NT user management, NT services management, and file system management. Unlike Netfinity Services Manager, this tool is concerned mainly with operating system management, not hardware management.

- NT Remote Display Client Products

  These applications enable you to launch native NT management applications on the Netfinity servers and display the application GUIs on the control workstation. This gives you the full functionality of any NT or Netfinity management application regardless of a given application's ability to provide a Web interface. To achieve this capability, you must purchase, install, and configure Windows NT 4.0 Terminal Server Edition on the target Netfinity server, along with a third party software package, Citrix MetaFrame by Citrix

Systems Inc. on the Netfinity server and the SP control workstation. After installation, the SP Perspectives launchpad must be configured to use the remote display client. See Configuring Optional NT Administration Products in the Netfinity section of the book *PSSP: Installation and Migration Guide*.

For installation instructions refer to the book *PSSP: Installation and Migration Guide*.

Managing Netfinity Nodes from Perspectives

Basic hardware control and monitoring of Netfinity nodes is provided through the SP Perspectives when you install the SP/Netfinity Server Consolidation software. This section provides information about using Perspectives to manage the Netfinity servers. For general information regarding SP Perspectives, see Chapter 19, "Using SP Perspectives" on page 293.

Three icons in the SP Perspectives Launch Pad provide access to Netfinity server management:

- Netfinity Services Manager

  This icon launches the Web interface for Netfinity Services Manager, the primary system management software provided by IBM with each Netfinity server. This is a hardware management interface.

- Windows NT Administration

  This icon launches the optional Web Administration for Windows NT Server, the Web-based NT administration interface. Unlike Netfinity Services Manager, this tool is concerned mainly with operating system management, not hardware management.

- Windows NT Desktop

  This icon launches the optional NT remote display client that you might have chosen to configure. For a list of the supported packages, see the Netfinity information in the book *PSSP: Installation and Migration Guide*.

Bringing up Perspectives

Use the **perspectives** command to bring up the SP Perspectives Launch Pad, then double-click on the Hardware Perspective icon. You can also start the Hardware Perspective, without opening the SP Perspectives Launch Pad, by using the **sphardware** command.

The default window for Hardware Perspective with the Netfinity management software installed contains:

- The tool bar with an icon to launch Netfinity Services Manager
- The CWS, System, and Syspars pane
- The Nodes pane (in frame view)
- The Netfinity nodes pane (frame view)

For specific information regarding the other icons appearing in the tool bar, or the panes, see the online Perspectives Help, which is accessible from the Launch Pad and this window.

The Netfinity Nodes Pane

The Netfinity Nodes pane enables you to:

- View the Netfinity nodes in icon, table, and frame view
- Display the Netfinity nodes notebook by double-clicking a Netfinity node, selecting a node and clicking the notebook icon on the tool bar, or using the Action drop-down menu.
- Power a Netfinity node on and off from the Tool bar, the Action drop-down menu, or the Notebook
- Acknowledge the state of monitored Netfinity nodes
- Monitor for the nodePowerDown condition

The Netfinity Node Notebook

The Netfinity Node notebook contains all attributes of the Netfinity nodes.

Access to Netfinity Services Manager has also been provided on the Node Status Page of the notebook.

For details and information about using the Netfinity node notebook, see the online Perspectives Help.

The Frame Pane

Netfinity nodes can only be monitored as contained objects in this pane. They can be monitored for the nodePowerDown condition.

The CWS, System, Syspars Pane

The CWS, System and Syspars pane will allow monitoring and hardware control of Netfinity nodes:

- Monitoring

  If the Syspars tab is selected from the Set Monitoring dialog box the nodePowerDown condition for the Netfinity nodes will appear as one of the conditions for contained objects and can be monitored.

  If the System tab is selected from the Set Monitoring dialog box the nodePowerDown condition for the Netfinity nodes will appear as one of the conditions for contained objects and can be monitored.

- Hardware Control

  If a system partition is selected and the Power On action is chosen from the tool bar, or the Actions menu, two dialog windows will be displayed; the SP Node Power On dialog box and the Netfinity Node Power On dialog box.

  If a system partition is selected and the Power Off action is chosen from the tool bar, or the Actions menu, two dialog windows will be displayed; the SP Node Power Off dialog box and the Netfinity Node Power Off dialog box.

Availability and Problem Management

Chapter 23. Managing a High Availability Control Workstation Configuration

This chapter provides overview and task information for the High Availability Control Workstation (HACWS) function. The HACWS function provides for a backup control workstation for your SP system.

IBM assumes that you have planned for, installed, and configured the HACWS function.

For information on planning for HACWS function, see the books *IBM RS/6000 SP: Planning Volume 1, Hardware and Physical Environment* and *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.

IBM also suggests that you refer to the documentation for IBM High Availability Cluster Multi-Processing for AIX (HACMP). The HACMP LPP is the foundation for HACWS function.

Information is provided in this chapter for the following tasks:

- Understanding HACWS function.
- Modifying typical administrative tasks (maintaining the **/etc/passwd** database, setting up mail spools, setting up file collections, for example) so that subsystems will fail over to the backup control workstation in the event the primary control workstation becomes unavailable. This information is covered in the order of the related chapters in the *PSSP: Administration Guide*:
  - Security Features of the SP System
  - Starting Up and Shutting Down the SP System
  - Remote Execution of SP Commands
  - Controlling Remote Execution using Sysctl
  - Managing File Collections
  - Managing User Accounts
  - Managing SP Resources
  - Managing Time Synchronization
  - Managing an Automounter
  - Managing Mail Service
  - Accounting
  - Using a Switch
  - Managing System Partitions
  - Managing Extension Nodes
  - Using the SP Perspectives
- Customizing HACMP
- Verifying Frame Supervisor Cables

Understanding HACWS Function

The following definitions will help in understanding HACWS function.

Primary control workstation
: The first control workstation that is installed with the SP system. The primary control workstation is a physical machine.

Backup control workstation
: The standby backup control workstation that is installed during the HACWS installation. The backup control workstation is a physical machine.

Active control workstation
: The control workstation that is currently running the SP control workstation applications (the SDR and **hardmon**, for example). This can be either the primary or backup control workstation.

Inactive control workstation
: The control workstation that is not running the SP control workstation applications. This can be either the primary or backup control workstation.

The HACWS function improves the reliability, availability and serviceability of an SP system by providing for a backup control workstation. HACWS provides for extending the SP system configuration to include a second RS/6000 to function as a backup to the primary control workstation. Automatic failover and reintegration to the backup control workstation are provided should the primary control workstation fail or in the case of taking the primary control workstation down to perform hardware and software maintenance.

HACWS provides hardware and software features that remove a single point of failure for the SP system. HACWS does not, however, protect against double failures. You should not expect control workstation functions to work during the time that a control workstation is failing over. If a failure on the control workstation occurs while a control workstation function is being performed, the function needs to be restarted.

The following figure illustrates a typical HACWS configuration:

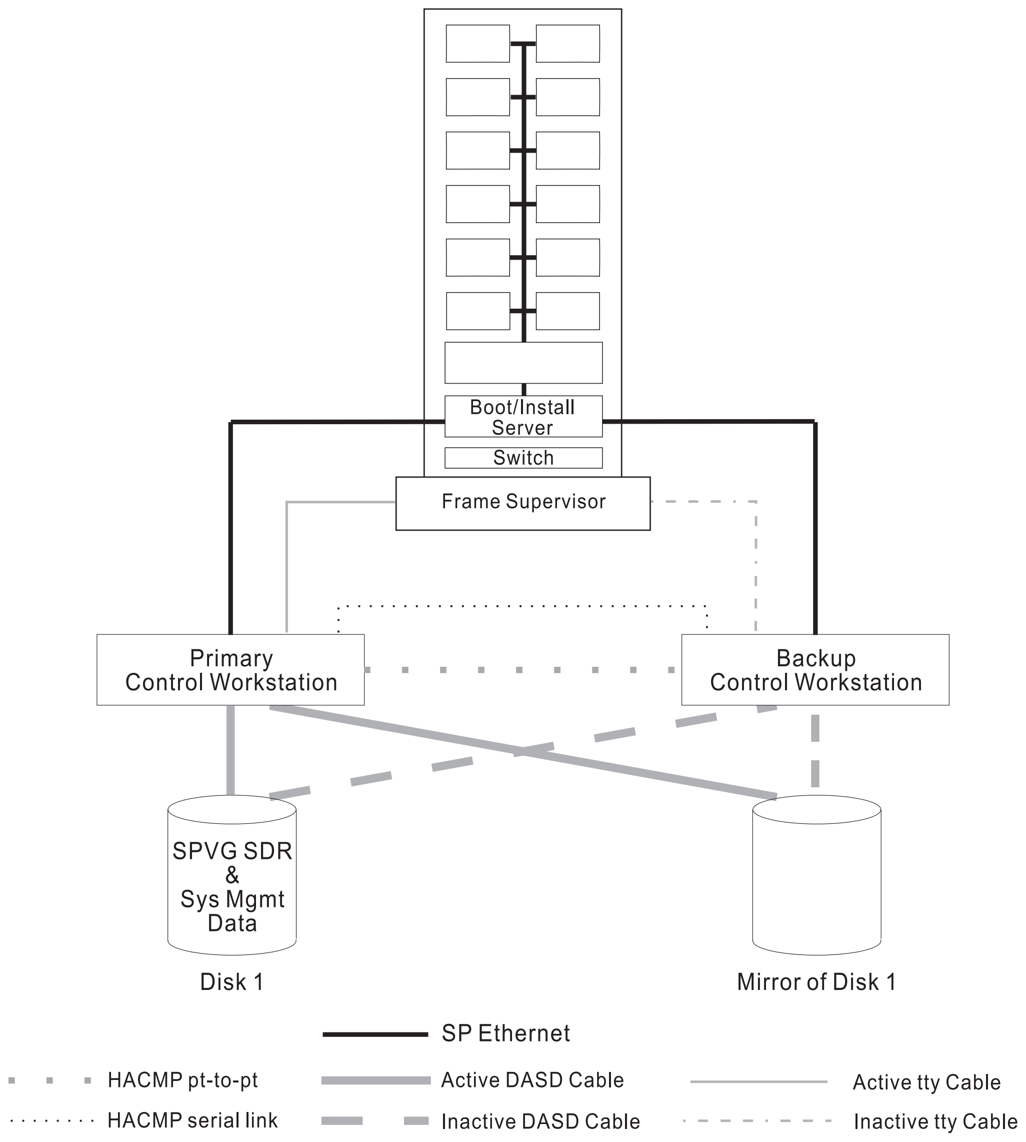


Figure 37. An HACWS Configuration

Hardware

HACWS is a two-node configuration: a primary control workstation with a backup control workstation. (Do not confuse the use of *node* in this context with an SP system node.) IBM suggests that the two RS/6000s be configured in the same way with the same model hardware and I/O configurations. This is not required, but simplifies the management of the HACWS configuration. IBM suggests that the primary and backup control workstations do not use the same power source.

External Fixed Disks and Disk Controllers

External fixed disks that provide only nonconcurrent access are used in an HACWS configuration. IBM suggests that the external fixed disks be mirrored across two disk controllers. If the external fixed disks are not mirrored, the single point of failure has not been removed from the SP system. The fixed disk becomes the single point of failure: if the disk fails the SP system will be down until the disk can be replaced. IBM suggests that the two disk controllers be on different power sources.

Frame Supervisor Cards

HACWS requires a dual RS-232 frame supervisor card per frame with a connection from each control workstation to each SP frame. Hardware feature #1245 provides this new type of frame supervisor card with an RS-232 Y-cable that connects from a frame in the SP system to the control workstation. All frames in the SP system need this new frame supervisor card and the Y-cables in order for the HACWS software to be configured. The frame supervisor connections from each frame must be connected to the same tty ports on both control workstations. If not cabled correctly, frame supervisor connections will not be activated by the hardware monitor.

SP-attached and Clustered Enterprise Servers

The control workstation is connected to RS/6000 Enterprise Servers S70, S7A, and S80 by two serial connections, making them SP-attached servers in an SP system or clustered enterprise servers in an independent system. One connection is for hardware monitoring and control and the other is for serial terminal support. Only one control workstation at a time can be connected to each server, so there is no automatic physical failover by HACWS. When the primary control workstation fails over to the backup control workstation, hardware control and monitoring support and serial terminal support are not available for these servers.

The following apply if you use HACWS support with SP-attached or clustered enterprise servers:

- Each server is directly attached to the control workstation through two RS-232 serial connections. There is no dual RS-232 hardware support for these connections like there is for SP frames. These servers can only be attached to one control workstation at a time. Therefore, when a control workstation fails or scheduled downtime occurs, and the backup control workstation becomes active, you will lose hardware monitoring and control and serial terminal support for the servers. The specific functions that are lost include:
  - Power on and off control
  - Reboot control
  - Serial port communications for s1term
  - Nodecond support to obtain the hardware Ethernet address and to network boot the node
  - Monitoring of the following Hardmon variables and state data (whether using the SP Perspectives graphical user interface, commands (like **hmmon**, **spmon**, **sphardware**), or RSCT resource variables):

    diagByte
    hardwareStatus
    lcd1
    lcd2
    LCDhasMessage
    nodefail1
    nodeLinkOpen1
    nodepower
    serialLinkOpen
    spcn
    SPCNhasMessage
    src

SRChasMessage
timeTicks

  – The ability to make configuration changes related to the servers. For example, you cannot add servers.

  – The ability to shutdown or restart the servers with a PSSP command.

- The servers will have the SP Ethernet connection from the backup control workstation, so PSSP components requiring this connection will still work correctly. This includes components such as the availability subsystems, user management, logging, authentication, the SDR, file collections, accounting and others.

Network Connections

One of the following network connections must exist between the primary and backup control workstations:

- A dedicated TCP/IP network link
- An RS-232 tty link
- The target mode SCSI across the external SCSI fixed disks

Note: IPv6 aliases are not supported. For more information about IPv6, see Appendix G, "Tolerating IPv6 Alias Addresses" on page 597.

Adapters

Each control workstation requires the same number of connections to the SP Ethernet on the same LAN segments. Each SP Ethernet LAN segment must be cabled to the same Ethernet (**en***x*) adapter. Standby network adapters are optional in an HACWS configuration because there may not be enough adapter slots in the control workstation for a standby adapter on each service network. On a small one- or two-frame SP system the normally used control workstation has only two slots and does not have enough slots for standby adapters. In a large multi-frame SP system the number of slots required for frame supervisor and SP Ethernet LAN segments may not allow for standby adapters. However, the presence of a standby adapter may avoid the need to fail over to the inactive control workstation.

Software

The software foundation for HACWS is the High Availability Cluster Multi-Processing for AIX (HACMP) licensed program product. Only the high availability subsystem is required. The concurrent Resource Manager of HACMP is not supported (all the SP data on the control workstation is in an AIX Journaled File System and, therefore, does not allow concurrent access).

You may use any level of HACMP that is supported with the level of AIX that you are using. Refer to the appropriate HACMP documentation to determine what levels of HACMP are supported with the level of AIX that you are using.

Note: In an HACWS configuration, the nodes may be running any level of AIX and PSSP.

The primary and backup control workstation are configured in a two-node rotating configuration. The external fixed disks are configured in nonconcurrent access only. For information on HACMP, refer to *HACMP: Concepts and Facilities*.

Building on HACMP, the **ssp.hacws** optional installation package that is part of the IBM Parallel System Support Programs for AIX provides:

- Scripts to create a backup control workstation
- Verification programs
- HACMP pre- and post- event scripts
- Scripts to synchronize the backup and primary control workstations

When a failure of the primary control workstation takes place there is a disruptive failover (that is, the failover is noticeable) of the control workstation to the backup control workstation. This failover:

1. Switches the external fixed disks
2. Reconfigures network adapters from boot addresses to service addresses to perform IP address takeover
3. Performs hardware address takeover
4. Remounts file systems
5. Restarts the control workstation applications
6. Resumes hardware monitoring
7. Allows clients to reconnect to obtain services or update control workstation data

The backup control workstation assumes the IP address (service address) and IP aliases of the primary control workstation, resulting in only one active control workstation at a time and allowing client applications to run without changes. *You cannot use IPv6 aliasing on a system with HACWS or HACMP.* See Figure 38 on page 333 for an illustration of addressing in an HACWS configuration.

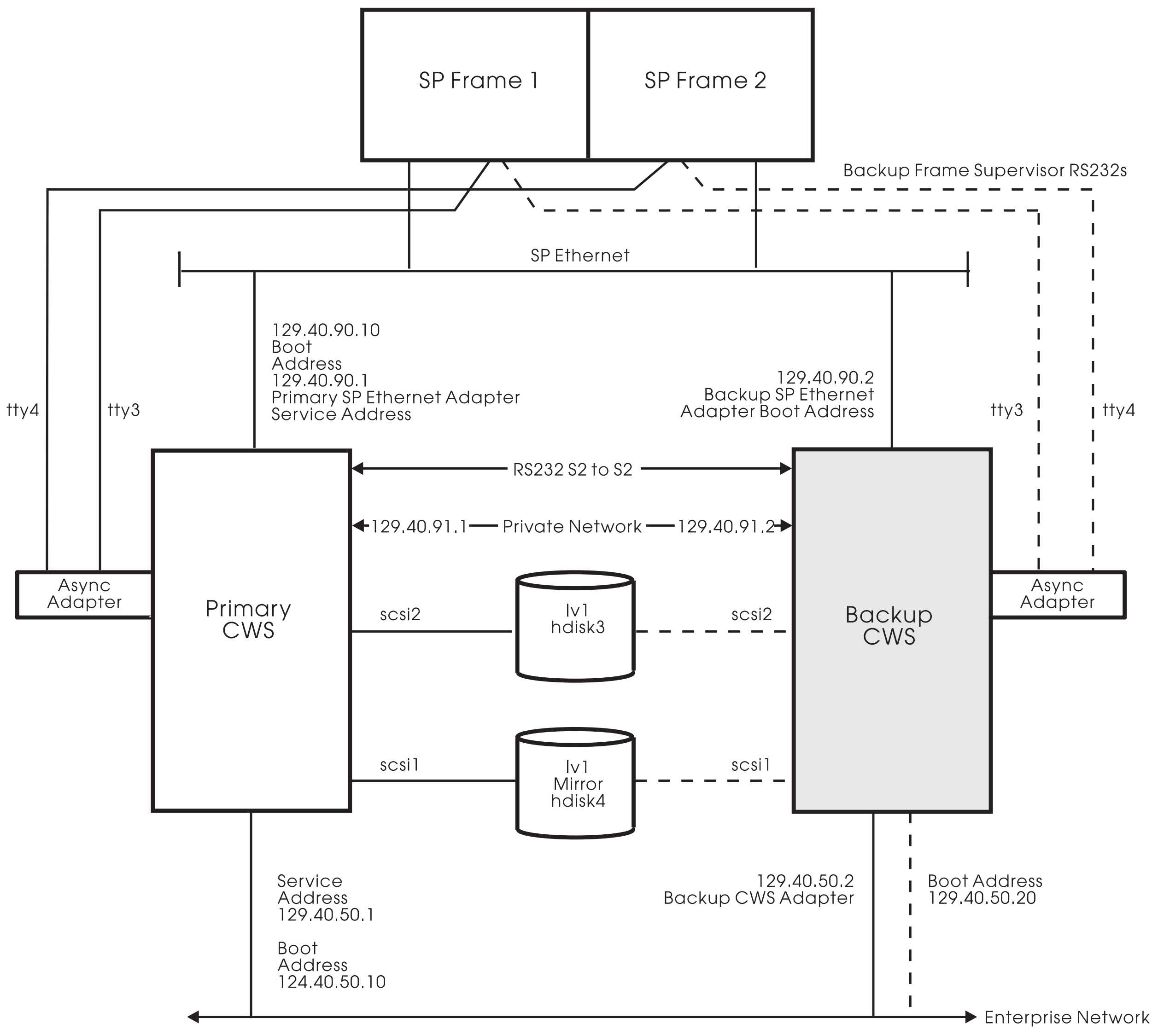


Figure 38. Addressing in an HACWS Configuration

Operating HACMP and the Control Workstation

This section describes some of the operational characteristics of the control workstation and HACMP.

Booting the Control Workstations

In a two-node rotating HACMP configuration, if you are booting both the primary and backup control workstations at the same time, the first control workstation to have the cluster manager started will acquire the shared resources. In an HACWS scenario this will cause the control workstation IP addresses (service address) and the **/spdata/sys1** file system to be configured on that control workstation. It is important that the RS/6000 that is intended to be the active control workstation have the HACMP cluster manager started on it first. To help ensure that the correct control workstation acquires the shared resources, IBM suggests that the cluster manager be started manually instead of being defined to start at system restart. This allows both control workstations to be booted in any order and any potential race conditions can be avoided during the boot process. After both control workstations are booted the cluster manager can be started on the intended control workstation.

If the control workstation function is started on the unintended control workstation, you can perform the following sequence of events to make the intended control workstation active:

1. Boot the intended control workstation without starting the cluster manager.
2. Do a graceful shutdown without takeover on the incorrectly active control workstation.

   Using SMIT:

   TYPE **smit clstop**

   - The Stop Cluster Services menu is displayed.

   SELECT now (for Stop now option)

   SELECT graceful (for Shutdown mode option)

   PRESS Enter (to Do)

   Using the Command Line:

   Enter

   ```
   /usr/sbin/cluster/utilities/clstop -y -N -g
   ```

   Note: **Never** use **kill** to stop the HACMP cluster manager. Doing so will cause the node to fail.

3. Start the cluster manager on the intended control workstation.

   Using SMIT:

   TYPE **smit clstart**

   - The Start Cluster Services menu is displayed.

   SELECT now (for Start now option)

   SELECT true (for Startup Cluster Information Daemon? option)

   Note: Don't use the **on system restart** option.

   PRESS Enter (to Do)

4. Execute the **clstat** utility to make sure HACMP is up and running on the correct control workstation.
5. Start the cluster manager on the inactive control workstation.

Avoiding False Adapter Failures on Configurations Without Standby Adapters

If a control workstation is configured without a standby adapter on one of its service networks, and the other control workstation is powered off, the HACMP software may find it difficult to determine service adapter failure. This is because the HACMP cluster manager cannot use a standby adapter to force packet traffic over the service adapter to verify its operation. This shortcoming is less of an exposure if one or more of the following is true:

1. There are network devices which answer broadcast ICMP ECHO requests. To verfiy this you can ping the broadcast address and determine the number of different IP addresses that respond.

2. The service adapter is under heavy use. In this instance the inbound packet count will continue to increase over the service adapter without stimulation from the cluster manager.

If neither of these cases is true, then HACMP might report that a service adapter has failed, even though there has not been a failure, because there are no other adapters with which to communicate. (For example, this can occur when all the nodes are powered off.)

An enhancement to **netmon**, the network monitor portion of the HACMP cluster manager, is described below. It can be configured to allow more accurate determination of a service adapter failure. This function can be used in configurations that require a single service adapter per network.

A **netmon** configuration file, **/usr/sbin/cluster/netmon.cf**, will specify additional network addresses to which ICMP ECHO requests can be sent. The configuration file consists of one IP address or IP label per line. The maximum number of addresses used is five. All addresses specified after the fifth will be ignored. No comments are allowed in the file.

The following is an example of a **netmon.cf** configuration file:

```
180.146.181.119
steamer
chowder
180.146.181.121
mussel
```

This file must exist at cluster startup. The cluster software will scan the configuration file during its initialization phase. When **netmon** needs to stimulate the network to verify adapter function, it will send ICMP ECHO requests to each address. After sending the request to every address, **netmon** will check the inbound packet count before determining whether there is an adapter failure.

Conditions that Cause a Failover of the Control Workstation

The following conditions will cause a failover of a control workstation:

1. An intentional failover

   This occurs when the operator stops the cluster manager on a node with a shutdown mode of **graceful with takeover**.

2. A failure of the operating system on the active control workstation

   If the AIX operating system fails, the cluster manager on the inactive control workstation will detect this by observing missed heartbeats. The cluster manager then declares the crashed control workstation dead and performs a takeover of the shared resources.

3. A failure of an external disk adapter that is not backed up

   If HACWS is configured with only one external disk adapter per control workstation, you need to write an Error Notification Object for the failure of the disk adapter to do a graceful shutdown with takeover. The other control workstation will then take over the shared resources.

4. A service network failure occurs on the active control workstation and the inactive control workstation is available to take over

A failure of a service adapter on the active control workstation, without a standby adapter to take over, will cause some SP node subsystems to perceive that the control workstation has failed and the system will quickly become unstable. To prevent such system instability, a service network failure on the active control workstation is promoted to a node failure, causing a failover to the inactive control workstation.

Failures that Do Not Cause a Failover of the Control Workstation

The following conditions will not cause a failover of a control workstation:

1. A hung control workstation with network adapters that still heartbeat

   In the case where the application software hangs and the network adapters being monitored via HACMP still respond to heartbeats from the inactive control workstation, HACMP will not detect the hang and will not fail over.

2. A service network failure occurs on the active control workstation and the inactive control workstation is not available to take over

   If the inactive control workstation is not available to take over, then a service network failure on the active control workstation will not be promoted to a node failure because no failover can occur.

General Guidelines for When to Do Configuration Changes

IBM suggests that you do configuration changes on the SP system only when the primary control workstation is the active control workstation. Most configuration changes are allowed when the backup control workstation is the active control workstation. However, if changes are made when the backup control workstation is active, some configuration files will need to be updated on the primary control workstation. When changes are made on the primary control workstation, some configuration files will need to be updated on the backup control workstation. If configuration changes are done on the backup control workstation, the updates go the opposite direction (backup to primary instead of primary to backup). It is easier to manage the system when the updates go only in one direction.

You can decide to what extent you do configuration changes on the backup control workstation. Because only two machines are involved, the bidirectional updates may not be a problem.

The following table lists tasks that can be performed in an HACWS configuration and whether or not it is possible to update configuration files on the active backup control workstation. A 'No' in the 'Backup CWS Active' column means that the file cannot be updated on the active backup control workstation. In that case, you will have to update the file on the primary control workstation when it is active again.

Table 14. High Availability Control Workstation Configuration and Task Summary

Task	Primary CWS Active	Backup CWS Active
Update passwords	Yes	No
Add or change users	Yes	No
Change Kerberos keys	Yes	No
Install a node	Yes	Yes
Change or add system partitions	Yes	Yes
Add nodes to the system	Yes	No
Hardware monitoring	Yes	Yes
Reboot nodes	Yes	Yes
Run diagnostics	Yes	Yes
Shut down and restart system	Yes	Yes
Run parallel jobs	Yes	Yes
Update file collections	Yes	Yes
Accounting	Yes	Yes
Change site environment information	Yes	No

The following table lists the tasks whose support is different for SP-attached servers if the active backup control workstation has not been enabled to the servers:

Table 15. High Availability Control Workstation and Task Summary (SP-attached servers)

Task	Backup CWS Active
Install an SP-attached server	No
Reboot SP-attached servers	No
Shut down and restart the system	Yes

Note that although you can shut down and restart the system with the SP-attached servers present, the attached servers will not be included in the process.

Managing SP Subsystems for High Availability Control Workstation Function

This section presents information on the administrative tasks you must perform to ensure that the various SP subsystems will fail over to the backup control workstation. The topics are presented in the same order as they are covered as chapters in this book.

Security Features of the SP System

This section discusses security issues that pertain specifically to HACWS.

DCE and HACWS

DCE and HACWS restriction:

If you plan to have DCE authentication enabled, you cannot use HACWS. If you already use HACWS, do not enable DCE authentication.

Kerberos V4 and HACWS

In an HACWS configuration the primary authentication service is **not** duplicated on the backup control workstation. If the primary control workstation is either a primary or secondary authentication server, then the backup control workstation must be a secondary authentication server. The backup control workstation cannot be a primary authentication server.

When the primary control workstation is down, and it is the primary authentication server, no updates to the authentication database can be made.

Kerberos Configuration Files

The backup control workstation needs to be added to the **.klogin** files on all the nodes and the control workstation. This **.klogin** file also needs to be kept in sync on the backup control workstation.

When control workstation services move back and forth between the two control workstations, the Kerberos server keys need to remain the same. To accomplish this, the following commands were issued on the backup control workstation when HACWS was initially configured:

```
$ /usr/lpp/ssp/rcmd/bin/rcp -p primary_name:/etc/krb-srvtab /etc/krb-srvtab.primary
$ cp -p /etc/krb-srvtab /etc/krb-srvtab.backup
$ cat /etc/krb-srvtab.primary >>/etc/krb-srvtab
```

Repeat this procedure whenever you change Kerberos server keys on either of the two control workstations.

Starting Up and Shutting Down the SP System

The sequence files need to be kept in sync between the primary and backup control workstations in order for the **cshutdown** command to work on the backup control workstation. The following files need to be synchronized:

- **/etc/cstartSeq**
- **/etc/shutSeq**
- **/etc/subsysSeq**

Remote Execution of SP Commands

You can use parallel management commands with the backup control workstation as a target, even when the backup control workstation is inactive, as long as the host name of the backup control workstation is listed in the working collective or host list.

Controlling Remote Execution using Sysctl

When Sysctl is installed the configuration file **/etc/sysctl.conf** is created and updated on the backup control workstation. If you update this file or use a different configuration file, the file needs to be kept in sync between the primary and backup control workstation.

The Sysctl ACL files must also be kept in sync between the primary and backup control workstations. This file is shipped as **/etc/sysctl.acl**. If you add an ACL record to the **/etc/sysctl.acl** file, the file should be kept in sync between the primary and backup control workstations.

When the backup control workstation is the inactive control workstation, Sysctl commands can be used because Sysctl is installed and running on the inactive control workstation.

Managing File Collections

The inactive control workstation acts as a file collection client (**supper** is run using **cron**). This keeps all the file collection files and other default file collections in sync between the primary and backup control workstations. If a configuration or file collection master change is done on the active control workstation, you should perform a **supper update** for the particular file collection. Note that you can do a **supper update** for all the file collections. If the update is not performed after the change and a failover occurs, the updates will not be on the new active control workstation and such updates will not be available to the SP nodes.

If you create scan files on the active control workstation, you need to make sure that the scan files get created on the takeover control workstation after a control workstation failover. Otherwise, the scan files may not exist or may be out-of-date on the takeover control workstation, and file collections will not function as expected. To automate the creation of scan files after a control workstation failover, create a file named **start_server.post_post_event** with execute permission for the root user in the **/var/adm/hacws/events** directory on both the primary and the backup control workstation with contents similar to the following:

```
#!/bin/ksh –x
exec /var/sysman/supper scan sup.admin user.admin power_system
```

If you have additional file collections that you are using scan files with, you will need to add those to the list in the previous supper command. For more information on using scan files, refer to “Verifying File Collections Using scan” on page 147.

Managing User Accounts

IBM suggests that HACWS configurations use NIS for user management when large numbers of users need to be managed on the SP system. NIS enforces a master-slave relationship for password databases and is easier to manage than file collections for user management in an HACWS configuration.

Using NIS with HACWS

If you are using NIS in an HACWS configuration and the NIS master database is the primary or backup control workstation, there must be at least one slave database within the NIS domain. For high availability of an SP system, IBM suggests that all the nodes where users log in be NIS slave database nodes.

Using File Collections with HACWS

If you use file collections for user management, the **/etc/passwd** and associated files should be on the primary control workstation. Once a failover occurs and the backup control workstation is the active control workstation, the actual master **passwd** files are no longer available to the backup control workstation. For this reason changing your passwords, gecos information, and login shell is not allowed when the backup control workstation is active. (This is similar to the restriction with NIS when the NIS master is down.) The backup control workstation, when inactive, will act as a file collection client (similar to an SP node) and update its **passwd** files from the primary control workstation when it is active.

Controlling User Login

If you are using login control on your SP system, the **spacs_data** must be kept in sync between the primary and backup control workstations. The **block_usr_sample** script and any derivatives of it need to be kept in sync between the primary and backup control workstations.

Managing SP Resources

When a failover or reintegration occurs, running parallel jobs should not be affected. LoadLeveler does not have a dependency upon the control workstation as long as the central manager is not being run on the control workstation.

Managing Time Synchronization

Both control workstations must use the same source for time (for example, timemaster, Internet, or consensus). NTP should be running on both the inactive and active control workstations.

Managing the Automounter

Include the backup control workstation in the distribution of automounter configuration and map files.

Managing Mail Service

If the primary control workstation is the mail hub, you should use NFS to export the **/var/spool/mail** file system to the backup control workstation so that mail files for nodes are put in the same file system. When a failover occurs you should have the **/var/spool/mail** locally mounted on the backup control workstation and the primary control workstation. Use NFS to mount the file on the control workstation when it is the inactive control workstation. The **/var/spool/mail** file system must be an externally mounted file system.

Accounting

If accounting was enabled in the Site Environment Information SMIT panel and the node number **0** was selected as the Accounting Master, you need to make a directory change. Create a symbolic link from both the primary and backup control workstations to put the **cacct** directory in the **/spdata/sys1** file system.

Do the following on both the primary and backup control workstations after accounting has been enabled:

1. Enter:

   ```
   ln -s /spdata/sys1/cacct /var/adm/cacct
   ```

   This creates a symbolic link between the **cacct** directory so that the data in the **rootvg** is automatically copied into the external file system when **crunacct** is run using **cron**. This allows accounting reports over a period of time to have no indication of which control workstation was active.

   On an inactive control workstation the **crunacct** and **cmonacct** scripts will fail because the symbolic link for the **cacct** directory on the inactive control workstation will not have a target directory.

2. To keep those scripts from failing, change the invocation in the **crontab** file to run a wrapper shell script that determines if the control workstation is the inactive control workstation. If the control workstation is the inactive control workstation, the script should exit without running the **cmonacct** or **crunacct** scripts. The **lshacws** command should be used for this. Alternatively, you may choose to let the script fail. The following is a sample script:

   ```
   #/bin/ksh
   # This is the state of the control workstation taking
   # the string output of the lshacws command.
   # It takes the name either crunacct or cmonacct
   # as an argument.

   HACWS_STATE=`lshacws`

   # Check to see if we are on an INACTIVE control workstation.
   # If we are, exit quietly, if not, run the argument passed.

   if [[ $HACWS_STATE = 1  ||  $HACWS_STATE = 16 ]] ; then
           exit 0
   else

   # Go run the command
   $1
   fi
   exit 0
   ```

Using a Switch

When an SP switch event occurs during a control workstation failover, the communication subsystem continues to handle switch faults, primary node failures, and primary backup node failures. System data about the switch is inaccessible during the control workstation failover and can become out-of-date. When the backup control workstation assumes the duties of the active control workstation, it must determine if a double failure has occurred (a switch event that occurred during a control workstation failover).

Perform the following to determine if a switch event has occurred and to synchronize the communication subsystem with the system data on the new control workstation:

1. To determine if a primary node takeover (failure) has occurred, check all nodes in each system partition for a file named **act.top.1** that contains a timestamp during the control workstation failover. For an SP Switch subsystem, it is in the **/var/adm/SPlogs/css** directory. For an SP Switch2 subsystem, it is in the **/var/adm/SPlogs/css0/p0** directory. If you locate an **act.top.1** file containing a timestamp during the control workstation failover:
   a. Run **/usr/lpp/ssp/css/rc.switch** on all the nodes in each system partition that has a node with an **act.top.1** file.
   b. Run **Estart** for each system partition that has a node with an **act.top.1** file.
2. To determine if a primary backup node failed or a switch fault occurred, examine the **flt** file on the primary node. For an SP Switch subsystem, it is in the **/var/adm/SPlogs/css** directory. For an SP Switch2 subsystem, it is in the **/var/adm/SPlogs/css0/p0** directory. If you find entries in the file that contain a timestamp during the control workstation failover, run **Estart** for each system partition having entries on its primary node.

   IBM suggests that you use an Error Notification Object for switch faults, primary node takeovers, and control workstation failures to send mail or a message to alert you about such double failures. You can then examine the communication subsystem as described previously. Because the timeframe and probability for these double failures are very small, IBM does not suggest that you run **rc.switch** or **Estart** whenever a control workstation failover occurs.

Managing System Partitions

System partition configuration changes must be done from the active control workstation. Such changes may be done on either the primary or backup control workstation, depending on which one is active. IBM suggests that configuration changes be done from the primary control workstation, but it is not required.

When you configure HACWS you are instructed to put IP address aliases that are required for partitioning or any other reason in a script called **/spdata/sys1/hacws/rc.syspar_aliases**. *Do not use the IPv6 form of IP address aliases on a system with HACWS or HACMP.* This script will be invoked by the HACWS event scripts at the correct times to enable system partitioning.

Managing Extension Nodes

The SP SNMP Manager that runs on the control workstation transfers dependent node configuration information to the SNMP Agent running on a dependent node. This SP SNMP Manager support will transfer to the active control workstation.

Using SP Perspectives

If you have installed **ssp.clients** or **ssp.gui** on an RS/6000 other than the primary or backup control workstations, carefully consider how you will monitor the SP system from other than the active control workstation. If you execute the **perspectives** commands without logging into the active control workstation and the active control workstation does a failover, this will not be represented on the SP Perspectives GUI until you take another action. Once you take another action, the **perspectives** commands will exit. You will have to execute the **perspectives** commands and reconnect to the currently active control workstation. This occurs because when you are monitoring a TCP/IP connection and the host fails, the client side of that connection does not know about the failure of the connection until a packet is sent from the client side of the connection. Since the users of the **perspectives** commands who are off the control workstation should be well known, an Error Notification Object can be set up to send mail or a message to the list of well known users to inform them that the control workstation has performed a failover. Such a notification list for the users that monitor the SP system is a good idea in any event. After a failover of a control workstation (or any other major recovery action) an administrator should be notified. Several options for such notification exist:

- Error Notification Objects
- NetView for AIX control desk alerts
- Trouble Ticket for AIX problem incidents
- HACMP Notify script

Viewing which Control Workstation is Active

With previous releases of PSSP, you could view which RS-232 tail was active using the Frame Environment Layout display of the SP System Monitor GUI. This information is now available using the hardware perspective. To display this information:

1. Ensure that the Frames/Switches pane is viewable. You may need to add a Frames/Switches pane first. Then, click in the pane to make it active and select a frame from the pane.
2. Select Actions → View and Modify Properties from the menu bar or just click on the Notebook icon.
3. Select the Frame Status page in the Frame notebook to view the information.

Customizing HACMP

To customize HACMP, follow the basic steps for configuring a two-node rotating configuration with nonconcurrent access in the *AIX High Availability Cluster Multi-Processing Installation Guide*.

Configuring Resources

When you get to the configuring resources step in the HACMP installation procedure, you need to define a resource group name. For an HACWS configuration, you **must** name the resource group **hacws_group1**. To define event scripts to handle failovers for HACWS configuration, the name of the resource group needs to be known. The HACWS configuration will not fail over if the **hacws_group1** resource group name is not used.

HACMP Event Processing

The HACWS software supplies HACMP pre- and post-event scripts for all HACMP events. These supplied pre- and post-event scripts are used to customize the HACMP configuration for HACWS. To permit you to add your own pre- and post-event scripts, HACWS software provides for pre- and post-event scripts in each pre- and post-event script that is supplied by HACWS. The following flow describes when the pre- and post-event scripts are called.

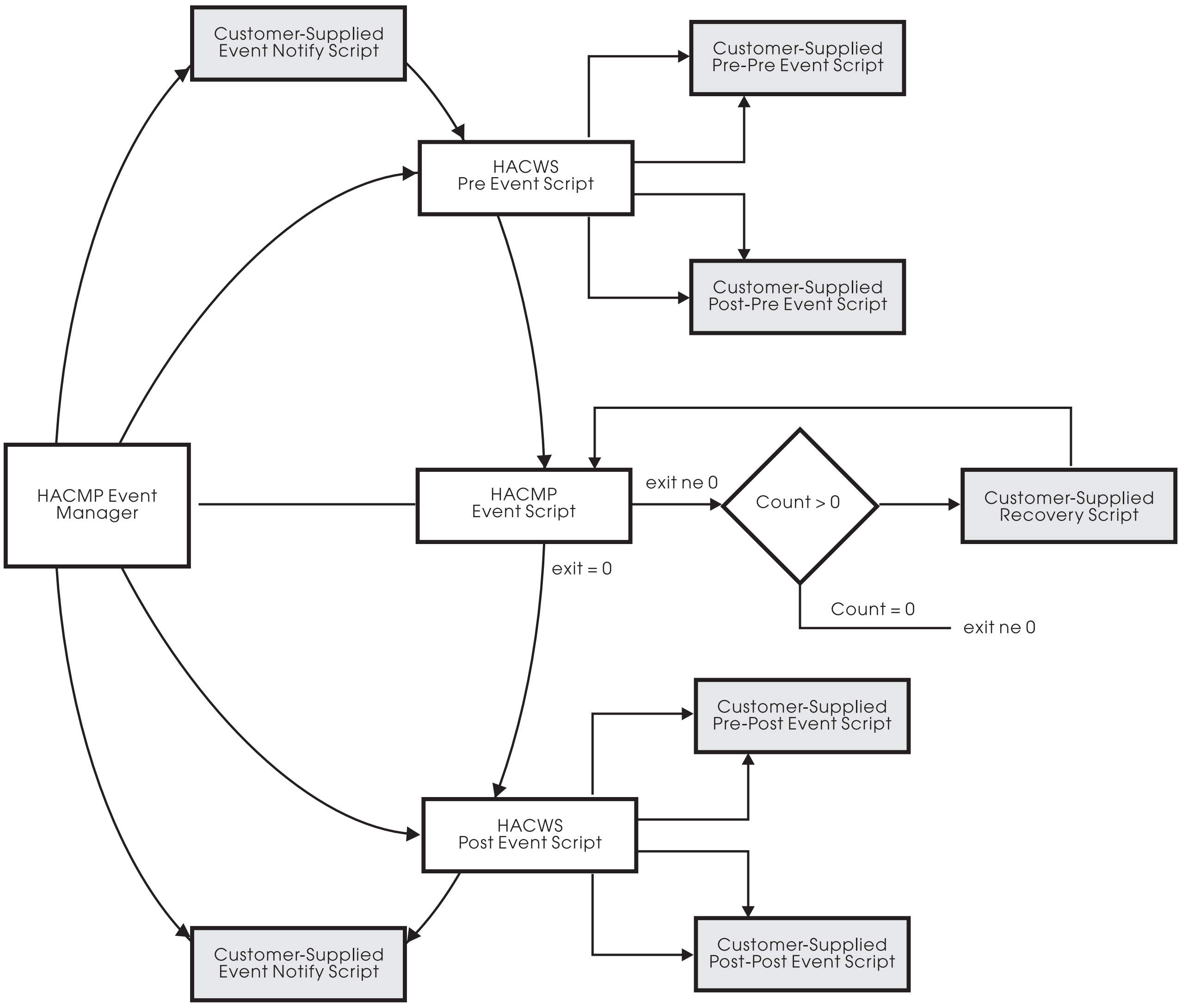

Customer-Supplied Event Notify Script
Customer-Supplied Pre-Pre Event Script
HACWS Pre Event Script
Customer-Supplied Post-Pre Event Script
HACMP Event Manager
HACMP Event Script
exit ne 0
Count > 0
Customer-Supplied Recovery Script
exit = 0
Count = 0
exit ne 0
Customer-Supplied Pre-Post Event Script
HACWS Post Event Script
Customer-Supplied Event Notify Script
Customer-Supplied Post-Post Event Script

Figure 39. HACWS Pre- and Post-Events

The pre- and post-event scripts supplied with HACWS function are located in the **/usr/sbin/hacws** directory. These scripts are defined to HACMP with the **spcw_addevents** command. Do not modify these scripts. These scripts are generic and will call the scripts supplied with HACWS (found in **/usr/sbin/hacws/events**) on a per event basis. Do not modify the per event scripts.

You may provide additional pre- and post-event scripts to be called by the pre- and post-event scripts supplied with HACWS. The additional scripts you provide must be located in the **/var/adm/hacws/events** directory.

Name the scripts you supply following this naming convention:

*event_name***.pre_pre_event**

event_name is the HACMP event name and **pre_pre_event** is the name for a pre-event script for an HACMP pre-event script. This naming convention extends to having **post_pre**, **pre_post** and **post_post** event scripts.

To enable the execution of event scripts, place the scripts in the proper directories and turn on the execution mode bits using the **chmod** command.

Verifying Frame Supervisor Cables

In an HACWS configuration the tty assignments for each frame **must** be identical on both the primary and backup control workstations. The new frame supervisor cards (Type 22 and 20) used for HACWS configurations have flash memory on the cards. This flash memory is used to write a unique ID so the frame can be identified. With previous cards the order in which the frames were cabled determined the frame numbers in the configuration. There was no method to check that the frame was actually still the same frame number.

If a frame number on the card does not match the frame number in the SDR, the hardware monitor will not bring the frame online. An error log entry is written to the AIX error log and BSD syslog indicating this. Note that in most cases of incorrect cabling, two frames will not be brought online. An error log entry will be written for each frame. You have to correct the cabling to repair the situation.

When the **hardmon** daemon initializes it verifies that the frame supervisor cables match the information in the SDR. To check that the cables are correct from an inactive control workstation (there must be an active control workstation in order to compare the SDR information):

1. Enter **stopsrc -s hardmon** to ensure there is no hardmon daemon running on the inactive control workstation.
2. Issue the **hardmon -B** command from the inactive control workstation.

Any cable problems will be written to the AIX error log.

When an SP system is reconfigured and frames are moved around and reassigned, new frame IDs need to be written to existing frames. Note that the system must be completely reinstalled so node numbers and system images are correct. This action should rarely, if ever, be taken.

The following example lists the steps to change the frame numbers in the flash memory of the card. In this example frame number 4 is now frame number 6 and frame number 6 is now frame number 4. A complete reinstall of the SP system is also being done. Note that it would be far easier to make the cables match and not swap frames around. Swapping frames should be done only in extreme cases.

1. Determine the tty number of the cable that is connected to the frames.
2. Verify the SDR information about the frame.

   Ensure that the SDR information about the frame and tty number match how the frame is cabled. Use the **SDRGetObjects Frame** command to see which frame number matches with which tty number. Assuming that the SDR information is correct, proceed to the next step.

   If the tty number in the SDR is incorrect, use the **spframe** command to make frame number 6 use the correct tty special device name. For example, if you want to make frame 6 use **/dev/tty6** (assuming no other frame is using **/dev/tty6**), enter **spframe 6 1 /dev/tty6**.
3. Set the frame ID in the flash memory.

   Enter **hcmds -G setid 4,6:0** to set the frame ID to the values in the SDR frame class for frames 4 and 6.

Chapter 24. The Topology Services Subsystem

This chapter introduces you to the Topology Services subsystem. It includes information about the components of the subsystem, its configuration, other components that depend on it, and how it operates. This chapter also discusses the relationship of the Topology Services subsystem to the other PSSP subsystems. Finally, it describes a procedure you can use to check the status of the subsystem.

After reading this chapter, you will be able to manage the Topology Services subsystem and, if necessary, perform problem determination.

Introducing Topology Services

Topology Services is a distributed subsystem of the IBM RS/6000 Cluster Technology (RSCT) software on RS/6000 systems. The RSCT software provides a set of services that support high availability on your SP system. Other services in the RSCT software are the Event Management and Group Services distributed subsystems. These three distributed subsystems operate within a domain. A domain is a set of RS/6000 machines upon which the RSCT components execute and, exclusively of other machines, provide their services. On an SP system, a domain is a system partition. Note that a machine might be in more than one RSCT domain; the control workstation is a member of each system partition, and, therefore, a member of each RSCT domain. When a machine is a member of more than one domain, there is an executing copy of each RSCT component per domain.

Topology Services provides other high availability subsystems with network adapter status, node connectivity information, and a reliable messaging service. The adapter status and node connectivity information is provided to the Group Services subsystem upon request, Group Services then makes it available to its client subsystems. The Reliable Messaging Service, which takes advantage of node connectivity information to reliably deliver a message to a destination node, is available to the other high availability subsystems.

This adapter status and node connectivity information is discovered by an instance of the subsystem on one node, participating in concert with instances of the subsystem on other nodes, to form a ring of cooperating subsystem instances. This ring is known as a heartbeat ring, because each node sends a heartbeat message to one of its neighbors and expects to receive a heartbeat from its other neighbor. Actually each subsystem instance can form multiple rings, one for each network it is monitoring. Usually, each subsystem monitors two rings; the SP Ethernet and the SP switch. This system of heartbeat messages enables each member to monitor one of its neighbors and to report to the heartbeat ring leader, called the Group Leader, if it stops responding. The Group Leader, in turn, forms a new heartbeat ring based on such reports and requests for new adapters to join the membership. Every time a new group is formed, it lists which adapters are present and which adapters are absent, making up the adapter status notification that is sent to Group Services.

In addition to the heartbeat messages, connectivity messages are sent around all rings. Connectivity messages for each ring will forward its messages to other rings, so that all nodes can construct a connectivity graph. It is this graph that determines node connectivity and defines a route that Reliable Messaging would use to send a message between any pair of nodes that have connectivity.

For more detail on maintaining the heartbeat ring and determining node connectivity, see “Topology Services Components.”

Topology Services Components

The Topology Services subsystem consists of the following components:

Topology Services Daemon	The central component of the Topology Services subsystem.
Port numbers	TCP/IP port numbers that the Topology Services subsystem uses for daemon-to-daemon communications. The Topology Services subsystem also uses UNIX domain sockets for server-to-client communication.
Control script	A shell script that is used to add, start, stop, and delete the Topology Services subsystem, which operates under the System Resource Controller (SRC) component.
Start-up script	A shell script that is used to obtain the configuration from the System Data Repository (SDR) and start the Topology Services Daemon. This script is invoked by the SRC component.
Files and directories	Various files and directories that are used by the Topology Services subsystem to maintain run-time data.

The sections that follow contain more details about each of these components.

The Topology Services Daemon (hatsd)

The Topology Services daemon is contained in the executable file **/usr/sbin/rsct/bin/hatsd**. This daemon runs on each node of an SP system partition and on the control workstation. If there is more than one system partition, then multiple daemons run on the control workstation, one for each system partition.

Note that the operational domain of the Topology Services subsystem is an SP system partition. The control workstation is considered to be part of each domain. Unless otherwise stated, a reference to "the Topology Services subsystem" is a reference to the Topology Services subsystem in a single system partition.

When each daemon starts, it first reads its configuration from a file set up by the Startup script (**hats**). This file is called the machines list file, because it has all the machines (nodes) listed that are part of the configuration and the IP addresses for each adapter for each of the nodes in that configuration. From this file, the daemon knows the IP address and node number of all the potential heartbeat ring members.

The Topology Services subsystem directive is to form as large a heartbeat ring as possible. To form this ring, the daemon on one node must alert those on the other nodes of its presence by sending a *proclaim* message. According to a hierarchy defined by the Topology Services component, daemons can send a proclaim message only to IP addresses that are lower than its own and can accept a proclaim message only from an IP address higher than its own. Also, a daemon only proclaims if it is the leader of a ring. When a daemon first starts up, it builds a heartbeat ring for every local adapter, containing only that local adapter. This is called a singleton group and this daemon is the leader in each one of these singleton groups.

To manage the changes in these groups, Topology Services defines the following roles for each group:

Group Leader	The daemon on the node with the local adapter that has the highest IP address in the group. The Group Leader proclaims, handles request for joins, handles death notifications, coordinates group membership changes, and sends connectivity information.
Crown Prince	The daemon on the node with the local adapter that has the second highest IP address in the group. This daemon can detect the death of the Group Leader and has the authority to become the leader of the group if that happens.
Mayor	A daemon on a node with a local adapter present in this group that has been picked by the Group Leader to broadcast a message to all the adapters in the group. When a daemon receives a message to broadcast, it is a mayor.
Generic	This is the daemon on any node with a local adapter in the heartbeat ring. The role of the Generic daemon is to monitor the heartbeat of the upstream neighbor and inform the Group Leader if the correct number of heartbeats have been missed.

Each one of these roles are dynamic, which means that every time a new heartbeat ring is formed, the roles of each member are evaluated and assigned.

In summary, Group Leaders send and receive proclaim messages. If the proclaim is from a leader with a higher IP address, then the group leader with the lower address replies with a join request. The higher address group leader forms a new group with all members from both groups. All members monitor their upstream neighbor for heartbeats. If a sufficient number of heartbeats are missed, a message is sent to the Group Leader and the unresponsive adapter will be dropped from the group. Whenever there is a membership change, Group Services is notified if it asked to be.

The Group Leader also accumulates node connectivity information, constructs a connectivity graph, and routes connections from its node to every other node in the SP system partition. The group connectivity information is sent to all nodes so that they can update their graphs and also compute routes from their node to any other node. It is this traversal of the graph on each node that determines which node membership notification is provided to each node. Nodes to which there is no route are considered unreachable and are marked as down. Whenever the graph changes, routes are recalculated, and a list of nodes that have connectivity is generated and made available to Group Services.

When a network adapter fails or has a problem in one node, the daemon will, for a short time, attempt to form a singleton group, since the adapter will be unable to communicate with any other adapter in the network. Topology Services will invoke a function which uses *self-death* logic. This self-death logic will attempt to determine whether the adapter is still working. This involves sending messages to other adapters in the network and monitoring the number of incoming packets. If no packets are received, the local adapter is considered to be down. Group Services is then notified that all adapters in the group are down.

After an adapter that was down recovers, the daemon will eventually find that the adapter is working again, by using a mechanism similar to the self-death logic, and will form a singleton group with it. This should allow the adapter to form a larger group with the other adapters in the network. An *adapter up* notification for the local adapter is sent to the Group Services subsystem.

Port Numbers and Sockets

The Topology Services subsystem uses several types of communications:

- UDP port numbers for intrapartition communications, that is, communications between Topology Services daemons within an SP system partition
- UNIX domain sockets for communication between Topology Services Clients and Topology Services daemon.

Intrapartition Port Numbers

For communication between Topology Services daemons within a system partition, the Topology Services subsystem uses a single UDP port number. This port number is recorded in the **Syspar_ports** SDR class. The class contains two attributes: subsystem and port. The class object whose subsystem attribute has a value of hats contains the port number for the Topology Services subsystem. Note that the **Syspar_ports** class is a partitioned SDR class: there is a set of objects for each SP system partition. When you configure the Topology Services subsystem for a particular system partition, you use the SDR data that corresponds to that system partition.

The Topology Services port number is stored in the SDR so that, when the Topology Services subsystem is configured on each node, the port number is retrieved from the SDR. This ensures that the same port number is used by all Topology Services daemons in the same system partition. Note that because a Topology Services daemon from each system partition runs on the control workstation, the Topology Services subsystem in each system partition must have a unique port number.

This intrapartition port number is also set in the **/etc/services** file, using the service name **hats**.*syspar_name*, where *syspar_name* is the name of the system partition. The **/etc/services** file is updated on all nodes in the system partition and on the control workstation. The Topology Services daemon obtains the port number from the **/etc/services** file during daemon initialization.

UNIX Domain Sockets

Unix domain sockets are used for communication between Topology Services clients (Group Services and Event Management), and the local Topology Services daemon. These are connection-oriented sockets. The socket name used to connect to the Topology Services daemon is **/var/ha/soc/hats/server_socket**.*syspar_name*, where *syspar_name* is the name of the system partition.

The Control Script (hatsctrl)

The Topology Services control script is contained in the executable file **/usr/sbin/rsct/bin/hatsctrl**. This script or command is normally invoked by the **syspar_ctrl** script, which provides an interface to all of the SP partition-sensitive subsystems.

If necessary, you can invoke the **hatsctrl** script directly from the command line. Before you run this command, be sure that the **SP_NAME** environment variable is set to the appropriate system partition name and that it is exported.

The purpose of the **hatsctrl** command is to add the Topology Services subsystem to the operating software configuration of an SP system partition. You can also use the command to remove the subsystem from a system partition, start the subsystem, stop the subsystem, and clean the subsystem from all system partitions.

For more information about the **hatsctrl** and **syspar_ctrl** commands, see the book *PSSP: Command and Technical Reference*.

Files and Directories

The Topology Services subsystem uses the following directories:

- **/var/ha/log**, for log files
- **/var/ha/run**, for Topology Services daemon current working directory
- **/var/ha/soc**, for socket files.

The /var/ha/log Directory (Log Files)

The **/var/ha/log** directory contains trace output from the Topology Services startup script (**hats**) and the daemon (**hatsd**).

There are three different log files that are created in this directory: the startup script log, the service version of the daemon trace log, and the user version of the daemon trace log. The files, each with the same names on the control workstation and on the nodes, have the following conventions:

1. The Topology Services log from the **hats** startup script is:

   hats.*syspar_name*[.*n*]

   where:

   syspar_name is the name of the system partition to which the node belongs.

   n is a number from 1 to 7 with **hats**.*syspar_name*.**1** being the most recent instance of the file and **hats**.*syspar_name*.**7** being the least recent instance.

   The seven most recent instances are kept and older instances are removed.

2. The service version of the log from the **hatsd** daemon is:

   hats.*DD.HHMMSS.syspar_name*

   where:

   DD is the Day of the Month that this daemon was started.

   HHMMSS is the Hour, Minute, and Second that the daemon was started.

syspar_name is the name of the system partition to which the node belongs.

The contents of this log might be used by IBM Service to help diagnose a problem. The five most recent instances of this file are kept and older instances are removed.

3. The user version of the trace log from the **hatsd** daemon is:

   hats.*DD.HHMMSS.syspar_name.locale*

   where:

   DD is the Day of the Month that this daemon was started.

   HHMMSS is the Hour, Minute, and Second that the daemon was started.

   syspar_name is the name of the system partition to which the node belongs.

   locale is the language locale in which the Topology Services daemon was started.

   This user version contains error messages that are issued by the **hatsd** daemon. The file provides detailed information that can be used together with the AIX error log for diagnosing problems.

The Topology Services daemon limits the size of both the service and user log files to 5,000 lines by default. That limit can be altered during system configuration. When the limit is reached, the **hatsd** daemon appends the string '**.bak**' to the name of the current log file and begins a new log file with the same original name. A file that already exists with the '**.bak**' qualifier is removed before the current log is renamed.

The /var/ha/run Directory (Daemon Working Files)

In the **/var/ha/run** directory, a directory named **hats**.*syspar_name* is created, where *syspar_name* is the system partition name. This directory is the current working directory for the Topology Services daemon. If the Topology Services daemon abnormally terminates, the core dump file is placed in this directory. Whenever the Topology Services daemon starts, it renames any core file to:

core.*DD.HHMMSS.syspar_name*

where:

DD is the Day of the Month that the daemon associated with this core file was started.

HHMMSS is the Hour, Minute, and Second that the daemon associated with this core file was started.

syspar_name is the name of the system partition to which the node belongs.

Components on which Topology Services Depends

The Topology Services subsystem depends on the following components:

System Resource Controller (SRC)
An AIX feature that can be used to define and control subsystems. The Topology Services subsystem is called **hats** on SP nodes and is called **hats**.*syspar_name* on the

control workstation, where *syspar_name* is the name of a system partition. The subsystem name is used with the SRC commands (for example, **startsrc** and **lssrc**).

System Data Repository (SDR)
A repository of SP system configuration information.

UDP/IP and Unix-domain socket communication
Topology Services daemons communicate with each other using the UDP/IP feature of AIX. Topology Service daemons communicate with client applications using UNIX-domain sockets.

SP switch (using UDP/IP communication)
Topology Services will form heartbeat rings on the SP switch network.

SP Security Services library and DCE security
The Topology Services subsystem uses the SP Security Services library when it is operating in a DCE security environment.

First Failure Data Capture (FFDC)
When the Topology Services subsystem encounters events that require system administrator attention, it uses the FFDC facility of RSCT to generate entries in an AIX error log.

Configuring and Operating Topology Services

The following sections describe how the components of the Topology Services subsystem work together to provide topology services. Included are discussions of the following Topology Services tasks:

- Configuring Topology Services
- Initializing Topology Services Daemon
- Operating Topology Services

Configuring Topology Services

RSCT is installed as part of the installation of the PSSP product. The Topology Services subsystem is contained in the **rsct.basic.rte** and **rsct.basic.sp** file sets. After the components are installed, you need to configure it for operation using the **hatsctrl** command, which is invoked by the **syspar_ctrl** command.

The **syspar_ctrl** command configures all of the system-partition-sensitive subsystems. The person who installs PSSP issues the **syspar_ctrl** command during installation of the control workstation. The **syspar_ctrl** command is executed automatically on the nodes when the nodes are installed. The **syspar_ctrl** command is also executed automatically when system partitions are created or destroyed. For more information on using this command, see the books *PSSP: Installation and Migration Guide* and *PSSP: Command and Technical Reference*.

The **hatsctrl** command provides a number of functions for controlling the operation of the Topology Services system. You can use it to:

- Add or configure the Topology Services subsystem

- Start the subsystem
- Stop the subsystem
- Delete or unconfigure the subsystem
- "Clean" all Topology Services subsystems
- Turn tracing of the Topology Services daemon on or off
- Refresh (read and dynamically reflect a updated configuration) the subsystem.

Except for the clean function, **hatsctrl** affects the Topology Services subsystem in the current system partition, that is, the system partition that is specified by the **SP_NAME** environment variable.

The SDR stores node and data information, as well as some tunable data. The class that holds this data is called the **TS_Config** class. This class holds information that controls some of the operation of Topology Services. The following is a list of the attributes in this class and a brief description of each:

Frequency	Controls how often Topology Services sends a heartbeat to its neighbors. The value is interpreted as the number of seconds between heartbeats. The minimum and default value is 1. On a system with a high amount of paging activity, this number should be kept as small as possible.
Sensitivity	Controls the number of missed heartbeat messages that will cause a Death in Family message to be sent to the Group Leader. Heartbeats are not considered missing until it has been twice the interval indicated by the Frequency attribute.
Run_FixedPri	Run the daemon with a fixed priority. Since Topology Services is a realtime application, there is a need to avoid scheduling conflicts. The number 1 indicates that the daemon is running with fixed priority, 0 indicates that it is not.
FixedPriValue	This is the actual fixed priority level that is used. The daemon will accept values greater than or equal to 10. The default is 38.
Log_Length	This is the approximate number of lines that a log file can hold before it wraps.
Pinning	This controls the memory Pinning strategy. Text causes the daemon to attempt to pin Text pages, Data attempts to pin Data Pages, Process attempts to pin all pages, and None causes no pages to be pinned. The default is Text.

On RS/6000 systems with heavy or unusual load characteristics, it might be necessary to adjust the Frequency and Sensitivity settings. See "Operating Topology Services Daemon" on page 357 for more information.

Adding the Subsystem

If the **hatsctrl** command is running on the control workstation, the first step in the add function is to select a Topology Services daemon communications port number and save it in the **Syspar_ports** SDR class. This port number is then placed in the /etc/services file. If the **hatsctrl** command is running on a node, the port number is fetched from the SDR and placed in the **/etc/services** file. Port number are selected from the range 10000 through 10100.

The second step is to add the Topology Services daemon to the System Resource Controller (SRC) using the **mkssys** command. On the control workstation, the IP address of the system partition is an argument to the **hats** command in the SRC subsystem specification.

The third step is to add an entry in the **/etc/inittab** file so that the Topology Services daemon will be started during boot. However, if **hatsctrl** is running on a High Availability Control Workstation (HACWS), an entry is not made in the **/etc/inittab** file. Instead, HACWS manages the starting and stopping of the Topology Services daemon.

Note that if the **hatsctrl** add function terminates with an error, you can rerun the command after fixing the problem. The command takes into account any steps that already completed successfully.

Starting and Stopping the Subsystem

The start and stop functions of the **hatsctrl** command run the **startsrc** and **stopsrc** commands, respectively. However, **hatsctrl** automatically specifies the subsystem argument to these SRC commands.

Deleting the Subsystem

The delete function of the **hatsctrl** command removes the subsystem from the SRC, removes the entry from **/etc/inittab**, and removes the Topology Services daemon communications port number from **/etc/services**. It does not remove anything from the SDR, because the Topology Services subsystem might still be configured on other nodes in the system partition.

Cleaning the Subsystem

The clean function of the **hatsctrl** command performs the same function as the delete function, except in all system partitions.

The clean function does not remove anything from the SDR. This function is provided to support restoring the system to a known state, where the known state is the (possibly restored copy of the) SDR database.

Tracing the Subsystem

The tracing function of the **hatsctrl** command is provided to supply additional problem determination information when it is requested by the IBM Support Center. Normally, you should not turn tracing on because it might slightly degrade Topology Services subsystem performance and can consume large amounts of disk space in the **/var** file system.

Initializing Topology Services Daemon

Normally, the Topology Services daemon is started by an entry in the **/etc/inittab** file using the **startsrc** command. If necessary, you can start the Topology Services daemon using the **hatsctrl** command or the **startsrc** command directly. The first part of initialization is done by the startup script, **hats**. It starts the **hatsd** daemon, which completes the initialization steps.

Understanding the Initialization Process

During this initialization, the startup script does the following:

1. Determine the number of the node by running the **/usr/lpp/ssp/install/bin/node_number** command. Node 0 is the control workstation.
2. Obtain the name of the system partition from the **Syspar** SDR class. (Remember, one instance of the Topology Services daemon runs on the control workstation for each system partition to which the Topology Services subsystem was added.)
3. If running on the control workstation, build a condensed version of the node and adapter configuration called the Machines List file. The name of the Machines List file is **machines.lst** and can be found in the Topology Services current working directory **/var/ha/run/hats.***syspar_name*, where *syspar_name* is the name of the system partition.

   The Machines List file also has tunable information from the **TS_Config** SDR class. Then compare this file with the one stored in the SDR. If they are different, update the one in the SDR to reflect any changes.
4. If not running on the control workstation, retrieve the **machines.lst** file from the SDR.
5. Perform file maintenance in the log directory and current working directory to remove the oldest log and rename any core files that might have been generated.
6. Start the Topology Services **hatsd** daemon.

The daemon then continues the initialization with the following steps.

1. Read the current Machines List file and initialize internal data structures.
2. Initialize daemon-to-daemon communication, as well as client communication.
3. For each local adapter defined, form a membership consisting of only the local adapter.

The daemon is now in its initialized state and ready to communicate with Topology Services daemons on other nodes. The intent is to expand each singleton membership group formed during initialization to contain as many members as possible. Each adapter has an offset associated with it. Only other adapter membership groups with the same offset can join together to form a larger membership group. Eventually, as long as all the adapters in a particular network can communicate with each other, there will be a single group to which all adapters belong.

Merging All Adapters into a Single Group

Initially the subsystem starts out as *N* singleton groups, one for each node. Each of those daemons is a Group Leader of those singleton groups and knows which other adapters could join the group by the configuration information. The next step is to begin proclaiming to subordinate nodes.

The proclaim logic tries to find members as efficiently as possible. For the first 3 proclaim cycles, daemons proclaim to only their own subnet, and if the subnet is broadcast-capable, that message is broadcast. The result of this is that given the previous assumption that all daemons started out as singletons, this would evolve into *M* groups, where *M* is the number of subnets that span this heartbeat ring. On the fourth proclaim cycle, those *M* Group Leaders send proclaims to adapters that are outside of their local subnet. This will cause a merging of groups into larger and larger groups until they have coalesced into a single group.

From the time the groups were formed as singletons until they reach a stabilization point, the groups are considered unstable. The stabilization point is reached when a heartbeat ring has no group changes for the interval of 10 times the heartbeat send interval. Up to that point, the proclaim continues on a 4 cycle operation, where 3 cycles only proclaim to the local subnets, and one cycle proclaims to adapters not contained on the local subnet. After the heartbeat ring has reached stability, proclaim messages go out to all adapters not currently in the group regardless of the subnet to which they belong. Adapter groups that are unstable are not used when computing the node connectivity graph.

Operating Topology Services Daemon

Normal operation of the Topology Services subsystem does not require administrative intervention. The subsystem is designed to recover from temporary failures, such as node failures or failures of individual Topology Services daemons. Topology Services also provides indications of higher level system failures. However, there are some operational characteristics of interest to system administrators and after adding or removing nodes or adapters, you might need to refresh the subsystem.

Defaults and Limitations

The maximum node number allowed is 2047. The maximum number of networks it can monitor is 16. The default number of networks monitored is 2, the SP Ethernet and the SP switch.

Topology Services is meant to be sensitive to network response and this sensitivity is tunable. However, other conditions can degrade the ability of Topology Services to accurately report on adapter or node membership. One such condition is the failure of AIX to schedule the daemon process in a timely manner. This can cause daemons to be late in sending their heartbeats by a significant amount. This can happen because an interrupt rate is too high, the rate of paging activity is too high, or there are other problems. If the daemon is prevented from running for enough time, the node might be considered to be down by other peer daemons. The *node down* indication, when propagated to subsystems like Virtual Shared Disks and General Parallel File System, will cause those subsystems to perform, in this case, undesirable recovery procedures and take over resources and roles of the node. Whenever these conditions exist, analyze the problem carefully to fully understand it.

Since Topology Services is a realtime process, do not intentionally subvert its use of the CPU because you can cause false indications.

Prior to AIX 4.2.1, Topology Services required you to set the network option **nonlocsrcroute** to 1 to enable IP source routing (the default is 0). AIX 4.2.1 and later releases now include network options for IP source routing as follows:

- **ipsrcroutesend** (default is 1)
- **ipsrcrouterecv** (default is 0)
- **ipsrcrouteforward** (default is 1)

Topology Services sets all four of these options to 1 so that the reliable message, feature which utilizes IP source routing, will continue to work. Disabling any of these network options can prevent the reliable message feature from working properly.

Tuning the Topology Services Subsystem

The default settings for the frequency and sensitivity tunable attributes discussed in "Configuring Topology Services" on page 353 are overly aggressive for SP system partitions that have more than 128 nodes or heavy load conditions. Using the default settings will result in false failure indications. Decide which settings are suitable for your system by considering the following:

- Higher values for the frequency attribute result in lower CPU and network utilization from the Topology Services daemon. Higher values for the product of frequency times sensitivity result in less sensitivity of Topology Services to factors that cause the daemon to be blocked or messages to not reach their destinations. Higher values for the product also result in Topology Services taking longer to detect a failed adapter or node.
- If the nodes are used primarily for parallel scientific jobs, use the following settings:

Frequency	Sensitivity	Seconds to detect node failure
2	6	24
3	5	30
3	10	60
4	9	72

- If the nodes are used in a mixed environment or for database workloads, use the following settings:

Frequency	Sensitivity	Seconds to detect node failure
2	6	24
3	5	30
2	10	40

- If the nodes tend to operate in a heavy paging or I/O intensive environment, as is often the case when running the GPFS software, use the following settings:

Frequency	Sensitivity	Seconds to detect node failure
1	12	24
1	15	30

These tunable attributes are typically set after the PSSP software is installed and configured on the control workstation and before installing it on the nodes. After PSSP has been installed and configured on the nodes, you must refresh the subsystem after making any tuning adjustments.

You can adjust the tunable attributes by using the **hatstune** command. For example, to change the frequency attribute to the value 2 and then refresh the Topology Services subsystem, use the command:

```
hatstune -f 2 -r
```

For more information about the **hatstune** command, see the book *PSSP: Command and Technical Reference*.

For more SP tuning information see the information at the Web address **http://www.rs6000.ibm.com/support/sp/**.

Refreshing the Topology Services Daemon

When your system configuration is changed (such as by adding or removing nodes, adapters, or frames), the Topology Services subsystem needs to be refreshed before it can recognize the new configuration.

In normal circumstances the procedure for changing your system configuration, as described in the book *PSSP: Installation and Migration Guide*, would have been followed. One of the steps is to run the **syspar_ctrl -r -G** command from the control workstation. Running that command does cause Topology Services and other partition-sensitive subsystems to refresh themselves. As discussed in "Initializing Topology Services Daemon" on page 355, the Topology Services startup script rebuilds the configuration and verifies its validity. The **machines.lst** configuration file is generated and the SDR copy of the file is updated to allow the nodes to retrieve the new copy. The daemon will be refreshed and then continue to operate using the new configuration. In unusual circumstances, where for some reason that step was not done or was not successful, you can run the **syspar_ctrl -r -G** command so that Topology Services and other subsystems can recognize the changes.

To refresh only the Topology Services subsystem, run the **hatsctrl -r** command from the control workstation. It will cause all the reachable nodes in the SP system partition to be refreshed.

Note that if there are nodes in the partition that are unreachable with Topology Services active, they will not be refreshed. Also, if the connectivity problem is resolved such that Topology Services on that node is not restarted, the node refreshes itself to remove the old configuration. Otherwise, it will not acknowledge nodes or adapters that are part of the configuration, but not in the old copy of the configuration.

Topology Services Procedures

Normally, the Topology Services subsystem runs itself without requiring administrator intervention. On occasion, you might need to check the status of the subsystem.

Displaying the Status of the Topology Services Daemon

You can display the operational status of the Topology Services daemon by issuing the **lssrc** command. Topology Services monitors the SP Ethernet and the SP switch networks, however, only the SP Ethernet is monitored from the control workstation. To see the status of both networks you need to run the command on a node that is up on the switch.

On the control workstation, enter:

lssrc -ls hats.*syspar_name*

where *syspar_name* is the name of the system partition.

On a node, enter:

lssrc -ls hats

In response, the **lssrc** command writes the status information to the standard output. The information includes:

- The information provided by the **lssrc -s hats** command (short form).
- Two lines for each Network for which this node has an adapter and includes the following information:
  - The network name.
  - The network index.
  - The number of defined members, number of adapters that the configuration reported existing for this network.
  - The number of members, number of adapters currently in the membership group.
  - The state of the membership group, denoted by S (Stable), U (Unstable), or D (Disabled).
  - Adapter ID, the address and instance number for the local adapter in this membership group.
  - Group ID, the address and instance number of the membership group. The address of the membership group is also the address of the group leader.
  - Adapter interface name.
- HB Interval, which corresponds to the **Frequency** attribute in the SDR **TS_Config** class. This exists both on a per network basis and a default value which could be different.
- HB Sensitivity, which corresponds to the **Sensitivity** attribute in the SDR **TS_Config** class. This exists both on a per network basis and a default value which could be different.
- The number of clients connected and the client process IDs and command names .
- Configuration Instance, the Instance number of the Machines List file.
- The address of the Control Workstation.
- Whether the daemon is working in a DCE security environment. If it is, the version number of the key used for mutual authentication is also included.
- The size of the data segment of the process and the number of outstanding allocate memory without corresponding free memory operations.
- Whether the daemon is processing a refresh request.
- Daemon process CPU time, both in user and kernel modes.
- The number of page faults and the number of times the process has been swapped out.
- The number of nodes that are seen as reachable (up) from the local node and the number of nodes that are seen as not reachable (down).
- A list of nodes that are either up or down, whichever list is smaller. The list of nodes that are down includes only the nodes that are configured and have at least one adapter which Topology Services monitors. Nodes are specified in the list using the format:

N1–N2(I1) N3–N4(I2)...

where *N1* is the initial node in a range, *N2* is the final node in a range, and *I1* is the increment. For example, 5–9(2) specifies nodes 5, 7, and 9. If the increment is 1 then the increment is omitted. If the range has only one node, only the one node number is specified.

The following is an example of the output from the **lssrc -ls hats** command on a node for the c47s system partition:

```
Subsystem         Group            PID     Status
 hats             hats             16792   active
Network Name   Indx  Defd    Mbrs  St   Adapter ID      Group ID
SPether        [ 0]   15      14    S   9.114.61.193    9.114.61.195
SPether        [ 0] en0                 0x37a1c9cd      0x37ce4a2c
HB Interval = 1 secs.  Sensitivity = 4 missed beats
SPswitch       [ 1]    14     13    S   9.114.61.137    9.114.61.154
SPswitch       [ 1] css0                0x37a1ca1a      0x37ce4a28
HB Interval = 1 secs.  Sensitivity = 4 missed beats
  2 locally connected Clients with PIDs:
haemd( 20664) hagsd( 20404)
  Configuration Instance = 934383365
  Default: HB Interval = 1 secs. Sensitivity = 4 missed beats
  Control Workstation IP address = 9.114.61.125
  Daemon employs no security
  Data segment size: 7116 KB. Number of outstanding malloc: 510
  User time 3018 secs. System time 2985 secs.
  Number of page faults: 392. Process swapped out 0 times.
  Number of nodes up: 14. Number of nodes down: 1.
  Nodes down: 6
```

The following is an example of the output from the **lssrc -ls hats.c47s** command on the control workstation:

```
Subsystem         Group            PID     Status
  hats.c47s       hats             14192   active
Network Name   Indx  Defd    Mbrs  St   Adapter ID      Group ID
SPether        [ 0]   15      14    S   9.114.61.125    9.114.61.195
SPether        [ 0] en0                 0x37c7244c      0x37ce4a2c
HB Interval = 1 secs.   Sensitivity = 4 missed beats
  2 locally connected Clients with PIDs:
haemd( 19882) hagsd( 16004)
Configuration Instance = 934383365
Default: HB Interval = 1 secs. Sensitivity = 4 missed beats
  Control Workstation IP address = 9.114.61.125
  Daemon employs no security
  Data segment size: 6820 KB. Number of outstanding malloc: 480
  User time 1850 secs. System time 1797 secs.
  Number of page faults: 357. Process swapped out 0 times.
  Number of nodes up: 14. Number of nodes down: 1.
  Nodes down: 6
```

The output of the **lssrc -l** command is shown in the language locale that is installed on the SP node where the **hats** daemon is running, which in this case is US English. Since different nodes on one SP system can have different language locales, it is also possible that the results of the **lssrc -l** command might not be legible to you. In such a heterogeneous SP system environment, you need to be careful to run commands that operate only on nodes that use the language locale you understand.

The two networks being monitored in the last example are named SPether and SPswitch. The SPether network has 15 adapters defined and 14 of them are members of the group. The group is in the stable state. The addresses of the local adapter and the group leader, and of the interface name of the local adapter are displayed. In the SPswitch network, there are 14 adapters defined and 13 of them are members in the group. Both networks have the same tunables which happen to have the default values. The daemons on both the node and the control workstation have two clients: the Group Services daemon and the Event Management Daemon. Of the 15 nodes in this configuration, including the control workstation, only node 6 is detected as being down.

The chapter on Topology Services in the book *PSSP: Diagnosis Guide* explains how to use the **lssrc** command to help in diagnosing problems related to the subsystem. It also contains explanation for the error log entries that might be generated by the subsystem.

Using Topology Services with DCE Security

In a message-based distributed system such as Topology Services, security is achieved by:

1. Authenticating the identity of message senders.
2. Identifying and discarding replayed messages.

Before PSSP 3.2, Topology Services did not use any authentication and message-replay identification mechanism. In PSSP 3.2, you can set a system partition-wide security policy and the Topology Services daemon complies with that policy. If the security policy requires it, the Topology Services daemon will use the DCE security services for daemon-to-daemon mutual authentication. It will also enable message-replay identification. In this case, the system clocks on all the nodes in a system partition must be synchronized within 120 seconds to prevent false message-replay identification. In the context of security, Topology Services is an SP trusted service.

In PSSP 3.2, the system administrator can enable any combination of the following authentication methods for use by all SP trusted services in a partition:

- **DCE**, where authentication is based on the DCE security services and message-replay identification is enabled.
- Compatibility (**compat**), where authentication is performed in a manner that is compatible with a pre-PSSP 3.2 version of the subsystem.

Since Topology Services did not use any authentication method before PSSP 3.2, enabling any combination of authentication methods that includes **compat** is equivalent to performing no authentication in Topology Services. For example, if the authentication methods are **compat** and **DCE** then the Topology Services daemon does not perform authentication. Topology Services enforces mutual authentication only when **DCE** is the sole authentication method enabled. Since use of DCE authentication by SP trusted services is available only in PSSP 3.2, this means Topology Services enforces mutual authentication only when all nodes in the SP system partition are running PSSP 3.2.

You can use the **/bin/lsauthpts** command to determine which authentication methods are currently enabled for SP trusted services in the SP system partition.

When DCE is the only authentication method enabled, for authentication purposes the Topology Services subsystem assumes the identity of different service principals at different stages:

- **ssp/spbgroot** is used to authenticate with the SDR daemon so that Topology Services scripts can update information in the SDR during configuration, initialization, and refresh.
- **rsct/hats** is used for daemon-to-daemon mutual authentication during normal operation.

Those service principals and associated key files are configured and initialized during system installation. This is done, for example, by using the **smit spauth_config** command. (See the book *PSSP: Installation and Migration Guide* for more information.) The key file associated with the **rsct/hats** principal is important for the authentication process. Its path name is **/spdata/sys1/keyfiles/rsct/***syspar_name***/hats**, where *syspar_name* is the name of the SP system partition.

Determining the Authentication Method Enabled in a Partition

Security has an important effect on the behavior of a Topology Services daemon: if the Topology Services subsystem on the control workstation cannot determine the authentication method to be used, then all Topology Services daemons in that SP system partition will cease their operations and terminate. If this happens, messages in the AIX error log explain the failure and possible solutions.

When the Topology Services startup script on the control workstation determines it is being initialized for the first time after installation, it attempts to determine which authentication methods are enabled in the SP system partition by using the **/bin/lsauthpts** command. If **DCE** is the only authentication method enabled, the script places special flags in the **machines.lst** file to indicate mutual authentication is to be performed. Similar action is taken by the startup script during Topology Services refresh. Special flags are placed in the **machines.lst** file indicating the authentication method.

Whenever daemons come up on the control workstation and on the nodes, they start mutual authentication only if the flags in the **machines.lst** file indicate that they should. Otherwise, no authentication is done. See “Initializing Topology Services Daemon” on page 355 for more on the initialization process.

Changing the Authentication Method and Key

You can change the authentication methods enabled in an SP system partition by using the **/bin/chauthpts** command. This command automatically invokes refresh operation on each of the SP trusted services. For Topology Services refresh, as already noted, the startup script attempts to determine the new authentication method, and the daemon complies accordingly. Also as already discussed, any combination of authentication methods, other than **DCE** only, is equivalent to no authentication.

In rare circumstances, primarily when you suspect that the key currently used for Topology Services mutual authentication might have been compromised, you need to change the key. Changing the key involves some manual steps. Perform these steps with extreme caution. Any mishap can adversely affect the normal operation of the entire SP system partition.

To add a key to the key file, do the following:

1. Run the following command on the control workstation:

   ```
   dcecp -c keytab add rsct/syspar_name/hats \
   -member /.../cell_name/rsct/syspar_name/hats \
   -registry -random
   ```

   where:

   syspar_name is the name of the SP system partition.

   cell_name is the name of the DCE cell.

2. Distribute the key file to all nodes in the SP system partition. Here are some ways to do that:

   - You can use the **dsh** facility to run the command **/usr/lpp/ssp/bin/spauthconfig** on all the nodes in the SP system partition.
   - You can use the **pcp** command to copy the key file **/spdata/sys1/keyfiles/rsct/***syspar_name***/hats** to all the nodes in the SP system partition.
   - If the circumstances are appropriate, you can reboot all the nodes in the SP system partition.

3. Confirm that all the nodes in the SP system partition have received the new key because the key files must be identical across the entire partition for the Topology Services daemons to be able to communicate.

4. Refresh Topology Services by running the following command on the control workstation:

   ```
   /usr/sbin/rsct/bin/hatsctrl -r
   ```

   The refresh is propagated automatically to all reachable nodes in the partition. Upon receiving the refresh, a Topology Services daemon retrieves the new key and starts the transition from old key to new key. The transition completes within minutes and all Topology Services daemons begin authenticating with the new key after that.

Chapter 25. The Group Services Subsystem

This chapter introduces you to the Group Services subsystem. It includes information about the component of the subsystem, the configuration, other components on which it depends, and how it operates. It also discusses the relationship of the Group Services subsystem to the other high availability subsystems in PSSP. Finally, it describes a procedure you can use to check the status of the subsystem.

After reading this chapter, you will be able to manage the Group Services subsystem and, if necessary, perform problem determination.

For more information, see the book *RS/6000 SP High Availability Infrastructure*.

Introducing Group Services

Group Services is a distributed subsystem of the IBM RS/6000 Cluster Technology (RSCT) software on RS/6000 systems. The RSCT software provides a set of services to PSSP that support high availability on your SP system. Other services in the RSCT software are the Event Management and Topology Services distributed subsystems. These three distributed subsystems operate within a domain. A domain is a set of RS/6000 machines upon which the RSCT components execute and, exclusively of other machines, provide their services. On the an SP system, a domain is a system partition. Note that a machine might be in more than one RSCT domain; the control workstation is a member of each system partition, and, therefore, a member of each RSCT domain. When a machine is a member of more than one domain, there is an executing copy of each RSCT component per domain.

The function of the Group Services subsystem is to provide other subsystems with a distributed coordination and synchronization service. These other subsystems that depend upon Group Services are called *client subsystems*. Each client subsystem forms one or more *groups* by having its processes connect to the Group Services subsystem and use the various Group Services interfaces. A process of a client subsystem is called a *GS client*. For example, Event Management is a Group Services client subsystem. The Event Manager daemon on each node is a GS client.

A group consists of two pieces of information:

- The list of processes that have joined the group, called the *group membership list*
- A client-specified *group state value*.

Group Services guarantees that all processes that are joined to a group see the same values for the group information, and that they see all changes to the group information in the same order. In addition, the processes may initiate changes to the group information via *protocols* that are controlled by Group Services.

A GS client that has joined a group is called a *provider*. A GS client that wishes only to monitor a group, without being able to initiate changes in the group, is called a *subscriber*.

Once a GS client has initialized its connection to Group Services, it can join a group and become a provider. All other GS clients that have already joined the group (those that have already become providers) are told as part of a join protocol about the new providers that wish to join. The existing providers can either accept new joiners unconditionally (by establishing a one-phase join protocol) or vote on the protocol (by establishing an n-phase protocol). During a vote, they can choose to approve the protocol and accept the new providers into the group, or reject the protocol and refuse to allow the new providers to join.

Group Services monitors the status of all the processes that are joined to a group. If either the process or the node on which a process is executing fails, Group Services initiates a failure protocol that informs the remaining providers in the group that one or more providers have been lost.

Join and failure protocols are used to modify the membership list of the group. Any provider in the group may also propose protocols to modify the state value of the group. All protocols are either unconditional (one-phase) protocols, which are automatically approved and not voted on, or conditional (n-phase) protocols, which are voted on by the providers.

During each phase of an n-phase protocol, each provider can take application-specific action and *must* vote to approve, reject, or continue the protocol. The protocol completes when it is either approved (the proposed changes become established in the group), or rejected (the proposed changes are dropped).

For more conceptual information about the Group Services subsystem, see *PSSP Group Services Programming Guide and Reference*.

Group Services Components

The Group Services subsystem consists of the following components:

Group Services daemon
The central component of the Group Services subsystem.

Group Services API (GSAPI)
The application programming interface that GS clients use to obtain the services of the Group Services subsystem.

Port numbers
TCP/IP port numbers that the Group Services subsystem uses for communications. The Group Services subsystem also uses Unix domain sockets.

Control script
A shell script that is used to add, start, stop, and delete the Group Services subsystem, which operates under control of the System Resource Controller (SRC) component of AIX.

Files and directories
Various files and directories that are used by the Group Services subsystem to maintain run-time data.

The sections that follow contain more details about each of these components.

The Group Services Daemon (hagsd)

The Group Services daemon is contained in the executable file **/usr/sbin/rsct/bin/hagsd**. This daemon runs on each node of a system partition and on the control workstation. If there is more than one system partition, then multiple daemons run on the control workstation, one per system partition.

Note that the operational domain of the Group Services subsystem on an SP system is a system partition. The control workstation is considered to be part of each domain. Unless otherwise stated, a reference to *the Group Services subsystem* is a reference to the Group Services subsystem in a single system partition.

A GS client communicates with a Group Services daemon that is running on the same node as the GS client. A GS client communicates with the Group Services daemon, through the GSAPI software, using a Unix domain socket. Before a GS client registers with Group Services, it must set the **HA_DOMAIN_NAME** environment variable to the name of the system partition in which it is executing. Note that for previous releases of Group Services, the GS clients needed to set the variable **HA_SYSPAR_NAME**. For PSSP 3.1, you can set either variable but to support compatibility of older clients, all new GS clients should use the variable **HA_DOMAIN_NAME** because the variable **HA_SYSPAR_NAME** might eventually be unsupported.

The Group Services API (GSAPI)

The Group Services Application Programming Interface (GSAPI) is a shared library that a GS client uses to obtain the services of the Group Services subsystem. This shared library is supplied in two versions: one for non-thread-safe programs and one for thread-safe programs. These libraries are referenced by the following path names:

- **/usr/lib/libha_gs.a** (non-thread-safe version)
- **/usr/lib/libha_gs_r.a** (thread-safe version)

These path names are actually symbolic links to the files **/usr/sbin/rsct/lib/libha_gs.a** and **/usr/sbin/rsctl/lib/libha_gs_r.a**, respectively. The symbolic links are placed in **/usr/lib** for ease of use. For serviceability, the actual libraries are placed in the **/usr/sbin/rsct/lib** directory. These libraries are supplied as shared libraries, also for serviceability.

For details on the GSAPI software, see *Group Services Programming Guide and Reference*.

To allow non-root users to use Group Services:

1. Create a group named **hagsuser**.
2. Add the desired user IDs to the **hagsuser** group.
3. Stop and restart **hags** (if it was running before you created the **hagsuser** group).

Users in the created **hagsuser** group can use Group Services (**libha_gs**).

Port Numbers and Sockets

The Group Services subsystem uses several types of communications:

- UDP port numbers for intra-domain communications, that is, communications between Group Services daemons within an operational domain.
- Unix domain sockets for communication between GS clients and the local Group Services daemon (via the GSAPI).

Intra-Domain Port Numbers

For communication between Group Services daemons within an operational domain, the Group Services subsystem uses a single UDP port number. This port number is recorded in the **Syspar_ports** SDR class. The class contains two attributes: *subsystem* and *port*. The *Syspar_ports* class object with a subsystem attribute value of **hags** contains the port number for the Group Services subsystem. Note that the **Syspar_ports** class is a partitioned SDR class, that is, there is a set of objects for each system partition. When you configure the Group Services subsystem for a particular system partition, use the SDR data that corresponds to that system partition.

The Group Services port number is stored in the SDR so that, when the Group Services subsystem is configured on each node, the port number is fetched from the SDR. This ensures that the same port number is used by all Group Services daemons in the same operational domain. Note that because a Group Services daemon from each operational domain runs on the control workstation, the Group Services subsystem in each system partition must have a unique port number.

This intra-domain port number is also set in the **/etc/services** file, using the service name **hags.***syspar_name*, where *syspar_name* is the name of the system partition. The **/etc/services** file is updated on all nodes in the system partition and on the control workstation. The Group Services daemon obtains the port number from the **/etc/services** file during initialization.

Unix Domain Sockets

Unix domain sockets are used for communication between GS clients and the local Group Services daemon (via the GSAPI). These are connection-oriented sockets. The socket name used by the GSAPI to connect to the Group Services daemon is **/var/ha/soc/hagsdsocket.***syspar_name*, where *syspar_name* is the name of the system partition.

The Control Script (hagsctrl)

The Group Services control script is contained in the executable file **/usr/sbin/rsct/bin/hagsctrl**. This script is normally invoked by the **syspar_ctrl** command, which provides an interface to all of the system-partition-sensitive subsystems.

If necessary, you can invoke the **hagsctrl** command directly from the command line. Note that before you invoke the **hagsctrl** command, you must ensure that the **SP_NAME** environment variable is set to the appropriate system partition name.

For more information about the **hagsctrl** and **syspar_ctrl** commands, see the book *PSSP: Command and Technical Reference*.

The purpose of the **hagsctrl** command is to add (configure) the Group Services subsystem to a system partition. It can also be used to remove the subsystem from a system partition, start the subsystem, stop it, and clean the subsystem from all system partitions.

For more information, see “Configuring Group Services” on page 370.

Files and Directories

The Group Services subsystem uses the following directories:

- **/var/ha/lck**, for lock files
- **/var/ha/log**, for log files
- **/var/ha/run**, for Group Services daemon current working directories
- **/var/ha/soc**, for socket files.

The /var/ha/lck Directory (Lock Files)

In the **/var/ha/lck** directory, the **hags.tid.***syspar_name* directory is used to ensure a single running instance of the Group Services daemon, and to establish an instance number for each invocation of the daemon. In the directory name, *syspar_name* is the name of the system partition. On the control workstation, there may be several instances of the Group Services daemon running, but they are in different operational domains.

The /var/ha/log Directory (Log Files)

The **/var/ha/log** directory contains trace output from the Group Services daemon.

On the nodes, the file is called **hags_***nodenum_instnum.syspar_name*, where:

- *nodenum* is the node number on which the daemon is running
- *instnum* is the instance number of the daemon.
- *syspar_name* is the name of the system partition to which the node belongs.

On the control workstation and the nodes, the file **hags.default.***syspar_name.nodenum_instnum* contains trace output from the initial startup of the daemon.

The Group Services daemon limits the log size to a pre-established number of lines (by default, 5,000 lines). When the limit is reached, the daemon appends the string **.bak** to the name of the current log file and begins a new log. If a **.bak** version already exists, it is removed before the current log is renamed.

The /var/ha/run Directory (Daemon Working Files)

In the **/var/ha/run** directory, a directory called **hags.***syspar_name* is created, where *syspar_name* is the system partition name. This directory is the current working directory for the Group Services daemon. If the Group Services daemon abnormally terminates, the core dump file is placed in this directory. Whenever the Group Services daemon starts, it renames any core file to **core_***nodenum.instnum*, where *nodenum* is the node number on which the daemon is running and *instnum* is the instance number of the previous instance of the daemon.

Components on Which Group Services Depends

The Group Services subsystem depends on the following components:

System Resource Controller (SRC)
An AIX feature that can be used to define and control subsystems. The Group Services subsystem is called **hags** on SP nodes and is called **hags.***syspar_name* on the control workstation, where *syspar_name* is the name of a system partition. The subsystem name is used with the SRC commands (for example, **startsrc** and **lssrc**).

System Data Repository (SDR)
A repository of SP system configuration information.

Topology Services
A PSSP subsystem that is used to determine which nodes in a system can be reached (that is, are running) at any given time. It is often referred to as **heartbeat**. The Topology Services subsystem is SRC-controlled. It is called **hats** on SP nodes and is called **hats.***syspar_name* on the control workstation, where *syspar_name* is the name of a system partition.

Configuring and Operating Group Services

The following sections describe how the components of the Group Services subsystem work together to provide group services. Included are discussions of Group Services:

- Configuration
- Daemon initialization and errors
- Operation

Configuring Group Services

The RSCT software is installed as part of the installation of the PSSP product. The Group Services subsystem is contained in **rsct.basic.rte** and **rsct.basic.sp** filesets.

After the components are installed, the subsystem must be configured for operation. Group Services configuration is performed by the **hagsctrl** command, which is invoked by the **syspar_ctrl** command.

The **syspar_ctrl** command configures all of the system-partition-sensitive subsystems. The person who installs PSSP issues the **syspar_ctrl** command during installation of the control workstation. The **syspar_ctrl** command is executed automatically on the nodes when the nodes are installed. The **syspar_ctrl** command is also executed automatically when system partitions are created or destroyed. For more information on using the **syspar_ctrl** command, see the books *RS/6000 SP: Installation Guide* and *PSSP: Command and Technical Reference*.

The **hagsctrl** command provides a number of functions for controlling the operation of the Group Services system. You can use it to:

- Add (configure) the Group Services subsystem

- Start the subsystem
- Stop the subsystem
- Delete (unconfigure) the subsystem
- Clean all Group Services subsystems
- Turn tracing of the Group Services daemon on or off

Except for the clean function, **hagsctrl** affects the Group Services subsystem in the current system partition, that is, the system partition that is specified by the **SP_NAME** environment variable.

Adding the Subsystem

If the **hagsctrl** command is running on the control workstation, the first step in the add function is to select a Group Services daemon communications port number and save it in the **Syspar_ports** SDR class. This port number is then placed in the **/etc/services** file. If the **hagsctrl** command is running on a node, the port number is fetched from the SDR and placed in the **/etc/services** file. Port numbers are selected from the range 10000 through 10100.

The second step is to add the Group Services daemon to the System Resource Controller (SRC) using the **mkssys** command. The system partition name is an argument to the **hagsd** program in the SRC subsystem specification.

The third step is to add an entry to the **/etc/inittab** file so that the Group Services daemon will be started during boot. However, if **hagsctrl** is running on a workstation with the High Availability Control Workstation (HACWS) component of PSSP, no entry is made in the **/etc/inittab** file. Instead, the HACWS component manages the starting and stopping of the Group Services daemon.

Note that if the **hagsctrl** add function terminates with an error, the command can be rerun after the problem is fixed. The command takes into account any steps that already completed successfully.

Starting and Stopping the Subsystem

The start and stop functions of the **hagsctrl** command simply run the **startsrc** and **stopsrc** commands, respectively. However, **hagsctrl** automatically specifies the subsystem argument to these SRC commands.

Deleting the Subsystem

The delete function of the **hagsctrl** command removes the subsystem from the SRC, removes the entry from **/etc/inittab**, and removes the Group Services daemon communications port number from **/etc/services**. It does **not** remove anything from the SDR, because the Group Services subsystem may still be configured on other nodes in the operational domain.

Cleaning the Subsystem

The clean function of the **hagsctrl** command performs the same function as the delete function, except in all system partitions. In addition, it removes the Group Services daemon remote client communications port number from the **/etc/services** file.

The clean function does **not** remove anything from the SDR. This function is provided to support restoring the system to a known state, where the known state is the (possibly restored copy of the) SDR database.

Tracing the Subsystem

The tracing function of the **hagsctrl** command is provided to supply additional problem determination information when it is requested by the IBM Support Center. Normally, tracing should **not** be turned on, because it might slightly degrade Group Services subsystem performance and can consume large amounts of disk space in the **/var** file system.

Initializing Group Services Daemon

Normally, the Group Services daemon is started by an entry in the **/etc/inittab** file, via the **startsrc** command. If necessary, the Group Services daemon can be started using the **hagsctrl** command or the **startsrc** command directly.

During initialization, the Group Services daemon performs the following steps:

1. It gets the number of the node on which it is running using the **/usr/lpp/ssp/install/bin/node_number** command. Node 0 is the control workstation.
2. It tries to connect to the Topology Services subsystem. If the connection cannot be established because the Topology Services subsystem is not running, it is scheduled to be retried every 20 seconds. This continues until the connection to Topology Services is established. Until the connection is established, the Group Services daemon writes an AIX error log entry periodically and no clients may connect to the Group Services subsystem.
3. It performs actions that are necessary to become a daemon. This includes establishing communications with the SRC subsystem so that it can return status in response to SRC commands.
4. It establishes the Group Services domain, which is the set of nodes within the SP system partition in which a Group Services daemon is executing.

   At this point, one of the GS daemons establishes itself as the GS nameserver. For details, see "Establishing the GS Nameserver."

   Until the domain is established, no GS client requests to join or subscribe to groups are processed.
5. It enters the main control loop.

   In this loop, the Group Services daemon waits for requests from GS clients, messages from other Group Services daemons, messages from the Topology Services subsystem, and requests from the SRC for status.

Establishing the GS Nameserver

The Group Services subsystem must be able to keep track of the groups that its clients want to form. To do this, it establishes a GS nameserver within each domain (a domain is the set of running nodes within each SP system partition). The GS nameserver is responsible for keeping track of all client groups that are created in that domain.

To ensure that only one node becomes a GS nameserver, Group Services uses the following protocol:

1. When each daemon is connected to the Topology Services subsystem, it waits for Topology Services to tell it which nodes are currently running in this system partition.
2. Based on the input from Topology Services, each daemon finds the lowest-numbered running node in the domain. The daemon compares its own node number to the lowest-numbered node and performs one of the following:
   - If the node the daemon is on is the lowest-numbered node, the daemon waits for all other running nodes to nominate it as the GS nameserver.
   - If the node the daemon is on is not the lowest-numbered node, it sends nomination messages to the lowest-numbered node periodically, initially every 5 seconds.
3. Once all running nodes have nominated the GS nameserver-to-be and a coronation timer (about 20 seconds) has expired, the nominee sends an insert message to the nodes. All nodes must acknowledge this message. When they do, the nominee becomes the established GS nameserver, and it sends a commit message to all of the nodes.
4. At this point, the Group Services domain is established, and requests by clients to join or subscribe to groups are processed.

Note that this description is in effect when all nodes are being booted simultaneously, such as at initial system power-on. It is often the case, however, that a Group Services daemon is already running on at least one node (for example, the control workstation) and is already established as the domain's GS nameserver. In that case, the GS nameserver waits only for Topology Services to identify the newly running nodes. The GS nameserver will then send the newly running nodes proclaim messages that direct the nodes to nominate it as nameserver. Once those nodes then nominate the GS nameserver, the GS nameserver simply executes one or more insert protocols to insert the newly-running nodes into the domain.

Group Services Initialization Errors

The Group Services subsystem creates AIX error log entries to indicate severe internal problems. For most of these, the best response is to contact the IBM Support Center.

However, if you get a message that there has been no heartbeat connection for some time, it could mean that the Topology Services subsystem is not running.

To check the status of the Topology Services subsystem, issue the **lssrc -g hats** command. If the response indicates that the Topology Services subsystem is inoperative, try to restart it using the **hatsctrl -s** command. If you are unable to restart it, call the IBM Support Center.

Group Services Daemon Operation

Normal operation of the Group Services subsystem requires no administrative intervention. The subsystem normally recovers from temporary failures, such as node failures or failures of Group Services daemons, automatically. However, there are some operational characteristics that might be of interest to administrators.

Due to AIX per-process file descriptor limits, the Group Services subsystem can support a maximum of approximately 2000 GS clients on each node.

The maximum number of nodes that can be contained within a domain is 2048, although Group Services can support node numbers in the range 0 to 65535.

The maximum number of groups to which a GS client can subscribe or that a GS client can join is equivalent to the largest value containable in a signed integer variable.

The maximum number of groups allowed within a domain is 65,535.

These limits are the theoretical maximum limits. In practice, the amount of memory available to the Group Services daemon and its clients will reduce the limits to smaller values.

Group Services Procedures

For the most part the Group Services subsystem runs itself without requiring administrator intervention. However, on occasion, you may need to check the status of the subsystem.

Displaying the Status of the Group Services Daemon

You can display the operational status of the Group Services daemon by issuing the **lssrc** command.

On the control workstation, enter:

lssrc -l -s hags.*syspar_name*

where *syspar_name* is the name of the system partition of interest.

On a node, enter:

lssrc -l -s hags

In response, the **lssrc** command writes the status information to standard output. The information includes:

- The information provided by the **lssrc -s hags** command (short form)
- The number of currently connected clients and their process IDs
- The status of the Group Services domain
- The node number on which the GS nameserver is running
- Statistics for client groups with providers or subscribers on this node.

Note that if the **lssrc** command times out, the Group Services daemon is probably unable to connect to the Topology Services subsystem. For more information, see “Group Services Initialization Errors” on page 373.

The following is sample output from the **lssrc -l -s hags** command on a node for the **k21sp2** system partition:

```
Subsystem         Group            PID     Status
 hags             hags             11938   active
 4 locally-connected clients.  Their PIDs:
 21344 17000 18852 23486
 HA Group Services domain information:
 Domain established by node 9.
 Number of groups known locally: 3
                   Number of   Number of local
 Group name        providers   providers/subscribers
 cssMembership           5           1          0
 WomSchg_1               5           1          1
 ha_em_peers             7           1          0
```

Here is a sample of the output of the **lssrc -l -s hags.k21sp2** command on the control workstation for the same domain:

```
Subsystem         Group            PID     Status
 hags.k21sp2      hags             24804   active
 1 locally-connected clients.  Their PIDs:
 44146
 HA Group Services domain information:
 Domain established by node 9.
 Number of groups known locally: 1
                   Number of   Number of local
 Group name        providers   providers/subscribers
 ha_em_peers             7           1          0
```

In this domain, the GS nameserver is on node 9 of the system partition.

If a GS nameserver has not yet been established, the status indicates that the domain is not established. Similarly, if the GS nameserver fails, the status shows that the domain is recovering. Both of these conditions should clear in a short time. If they do not and the Topology Services subsystem is active, call the IBM Support Center.

Using Group Services with DCE Security

The Group Services subsystem, like Topology Services, is an SP trusted service that achieves security by authenticating the identity of message senders. Group Services shares the same security policy with Topology Services according to the SP security configuration established in the SP system partition.

The authentication methods enabled can be DCE, compatibility, both, or none. However, Group Services activates the authentication procedure only when DCE is the sole authentication method enabled and all nodes within the SP system partition are running PSSP 3.2. No authentication methods between nodes are activated if any node uses the compatibility method or is running an earlier level than PSSP 3.2.

Because Group Services shares the same security policy of Topology Services, the security principal **rsct/hats** and the associated key files are the same. Furthermore, any security changes made for Topology Services automatically effect Group Services as well. For related information, see "Using Topology Services with DCE Security" on page 362.

Chapter 26. The Event Management Subsystem

This chapter introduces you to the Event Management (EM) subsystem. It includes information about the subsystem components, configuration, other components on which it depends, and how it operates. It also discusses the relationship of the Event Management subsystem to the other high availability subsystems. Finally, it contains procedures you can use to check the status of the subsystem, to add, or to change some of the Event Management configuration data.

For more information on Event Management, see the book *RS/6000 SP High Availability Infrastructure* and the IBM Redbook named *SP Monitoring: Keeping it Alive*.

After reading this chapter, you will be able to manage the Event Management subsystem and, if necessary, perform problem determination.

Introducing Event Management

Event Management is a distributed subsystem of the RS/6000 Cluster Technology (RSCT) on the RS/6000 system. The RSCT provides a set of high availability services to the IBM Parallel System Support Programs (PSSP). The other services in RSCT are the Group Services and Topology Services (heartbeat) distributed subsystems. These three distributed subsystems operate within a **domain**. A domain is a set of RS/6000 machines where the RSCT components execute and, exclusively of other machines, provide their services. On the RS/6000 SP, a domain is a system partition. Note that a machine may be in more than one RSCT domain; the control workstation is a member of each system partition and, therefore, a member of each RSCT domain. When a machine is a member of more than one domain, there is an executing copy of each RSCT component per domain.

The function of the Event Management subsystem is to match information about the state of system resources with information about resource conditions that are of interest to client programs, which may include applications, subsystems, and other programs. In this chapter, these client programs are referred to as **EM clients**.

Resource states are represented by resource variables. Resource conditions are represented as expressions that have a syntax that is a subset of the expression syntax of the C programming language.

Resource monitors are programs that observe the state of specific system resources and transform this state into several resource variables. The resource monitors periodically pass these variables to the Event Manager daemon. The Event Manager daemon applies expressions, which have been specified by EM clients, to each resource variable. If the expression is true, an event is generated and sent to the appropriate EM client. EM clients may also query the Event Manager daemon for the current values of resource variables.

Resource variables, resource monitors, and other related information are specified in several System Data Repository (SDR) object classes. Information stored in these SDR classes is then translated into a form that can be easily used by the Event Management subsystem.

For more conceptual information about the Event Management subsystem, or to learn how to use the Event Management Perspective to view descriptions of resource variables, see the RS/6000 Cluster Technology *Event Management Programming Guide and Reference*.

Event Management Components

The Event Management subsystem consists of the following components:

Event Manager daemon
The central component of the Event Management subsystem.

Event Management API (EMAPI)
The application programming interface that EM clients use to obtain the services of the Event Management subsystem.

Resource Monitor API (RMAPI)
The application programming interface that resource monitors use to supply resource variables to the Event Manager daemon.

Resource monitors Programs that monitor the state of system resources. Several resource monitors are shipped with RSCT.

Port numbers TCP/IP port numbers that the Event Management subsystem uses for communications. The Event Management subsystem also uses Unix domain sockets.

Configuration data Information that defines resource variables, resource monitors, and related data to the Event Management subsystem. This information is stored in the SDR.

Configuration utility
A program that translates the Event Management configuration data that is stored in the SDR to a binary format that is used by the Event Manager daemon and the RMAPI.

Configuration database
The Event Management Configuration Database (EMCDB) is the output of the configuration utility.

Control script A shell script that is used to add, start, stop, and delete the Event Management subsystem, which operates under System Resource Controller (SRC) control.

Configuration load utility
A program that loads the default configuration data that is shipped with RSCT into the SDR.

Default configuration data
A file that is shipped with RSCT that contains the default configuration data for the Event Management subsystem.

Files and directories
Various files and directories that are used by the Event Management subsystem to maintain run-time data.

The sections that follow contain more details about each of these components.

The Event Manager Daemon (haemd)

The Event Manager daemon is contained in the executable file **/usr/sbin/rsct/bin/haemd**. This daemon runs on each node (machine) of a domain. If a node is a member of more than one domain, there is one executing copy of the daemon per domain.

Note that on the RS/6000 SP, the domain of the Event Management subsystem is a system partition. The domain name is the same as the system partition name. The control workstation is regarded as node 0 in each system partition and, therefore, in each domain. Unless otherwise stated, a reference to the "Event Management subsystem" is a reference to the Event Management subsystem in a single domain.

EM clients communicate with a single Event Manager daemon in the domain that contains the resources in which they are interested, as follows:

- If the domain contains the SP node where the EM client is running, the client communicates with the local Event Manager daemon, through the EMAPI, using a Unix domain socket.
- If an EM client is running on the control workstation, it must specify, explicitly or implicitly, a domain. The EM client then communicates with the Event Manager daemon on the control workstation, in that domain, using a Unix domain socket.

An EM client that is running on a node that is outside of the domain that contains the resources in which it is interested uses a TCP socket to communicate with the Event Manager daemon on the control workstation that is in that domain. An EM client that is running on any RS/6000 is considered to be on a node outside of any domain. In both of these cases, the Event Management client must specify, explicitly or implicitly, the name of a domain that contains the resources of interest. For an Event Management client to run on a RS/6000, the RSCT filesets **rsct.clients.rte** and **rsct.clients.sp** and the PSSP fileset **ssp.clients** must be installed on the RS/6000.

Once an EM client has established communications with an Event Manager daemon, the EM client has access to all of the resources in that domain.

Resource monitors communicate with the Event Manager daemon, through the RMAPI, using Unix domain sockets. Resource monitors are always on the same node as the Event Manager daemon. Note that if a node is a member of multiple domains, just as there is one executing copy of the daemon per domain, there is also one executing copy of each resource monitor per domain.

The Event Management API (EMAPI)

The Event Management Application Programming Interface (EMAPI) is a shared library that an EM client uses to obtain the services of the Event Management subsystem. This shared library is supplied in two versions: one for non-thread safe programs and one for thread-safe programs. These libraries are referenced by the following path names:

- **/usr/lib/libha_em.a** (non-thread safe version)
- **/usr/lib/libha_em_r.a** (thread-safe version)

These path names are actually symbolic links to **/usr/sbin/rsct/lib/libha_em.a** and **/usr/sbin/rsct/lib/libha_em_r.a**, respectively. The symbolic links are placed in **/usr/lib** for ease of use. For serviceability, the actual libraries are placed in the **/usr/sbin/rsct/lib** directory. These libraries are supplied as shared libraries, also for serviceability.

For details on the EMAPI, see *Event Management Programming Guide and Reference*.

The Resource Monitor API (RMAPI)

The Resource Monitor Application Programming Interface (RMAPI) is a shared library that a resource monitor uses to supply resource variables to the Event Manager daemon. This shared library is supplied only in a non-thread safe version. This library is referenced through the path name

- **/usr/lib/libha_rr.a**

which is a symbolic link to **/usr/sbin/rsct/lib/libha_rr.a**. The symbolic link is placed in **/usr/lib** for ease of use. For serviceability, the actual library is placed in the **/usr/sbin/rsct/lib** directory. This library is supplied as a shared library, also for serviceability.

For details on the RMAPI, see *Event Management Programming Guide and Reference*.

Resource Monitors

A resource monitor conforms to one of the following programming models:

- The resource monitor is a daemon. When necessary, it is started by the Event Manager daemon. The Event Manager daemon connects to the resource monitor to establish communications. The resource monitor has a connection type of **server**.
- The resource monitor logic is incorporated in a subsystem that manages the resources. The Event Manager daemon connects to the resource monitor to establish communications, but the Event Manager daemon does not start the resource monitor (because it is actually another subsystem). The resource monitor has a connection type of **server**.
- The resource monitor logic is implemented in a command. The command can be used by scripts to supply resource variables to the Event Manager daemon. A command-based resource monitor connects to the Event Manager daemon to establish communications. The resource monitor has a connection type of **client**.

Note that a **server** type resource monitor may have multiple executing copies or *instances.* Each resource monitor instance may supply different instances of the same named resource variable or may supply different resource variables.

In addition, the Event Manager daemon itself performs some resource monitoring function. This function is considered to be a resource monitor with a connection type of **internal**.

RSCT supplies the following resource monitors:

IBM.PSSP.harmld	Supplies resource variables for the CSS, VSD, and LoadLeveler subsystems. This data is also furnished to the Performance Monitor subsystem. This is a daemon with a connection type of **server**.
IBM.PSSP.harmpd	Supplies resource variables that represent the number of processes executing a particular program. These variables can be used to determine whether a particular system daemon is running. This is a daemon with a connection type of **server**.
IBM.PSSP.hmrmd	Supplies resource variables that represent the hardware state of the SP system. The resource information is obtained from the PSSP hardware monitoring subsystem (**hardmon**). This is a daemon with a connection type of **server**.
IBM.PSSP.pmanrmd	Supplies resource variables provided by the PSSP Problem Management subsystem. This is a command-based resource monitor with a connection type of **client**.
aixos	Supplies resource variables that represent AIX operating system resources. This is a daemon with a connection type of **server**.
IBM.PSSP.CSSLogMon	Supplies a resource variable that represents the state of CSS error log entries. This is a command-based resource monitor with a connection type of **client**.
IBM.PSSP.SDR	Supplies a resource variable that represents the modification state of SDR classes. This is a command-based resource monitor with a connection type of **client**.

There are also several internal resource monitors incorporated in the Event Manager daemon itself:

Membership	Supplies resource variables that represent the Host Membership and Adapter Membership states. The Event Manager daemon obtains this information directly from the Group Services subsystem by subscribing to the **HostMembership**, **enMembership**, and **cssMembership** system groups.
Response	Supplies resource variables that represent the information in the **host_responds** and **switch_responds** SDR classes. These resource variables are provided for compatibility with earlier releases of PSSP.

Port Numbers and Sockets

The Event Management subsystem uses several types of communications:

- UDP port numbers for intra-domain communications, that is, communications between Event Manager daemons within a domain.
- TCP port numbers for remote communications, that is, communications between Event Manager daemons and EM clients that are running outside their domains.

- Unix domain sockets for communication between EM clients and the local Event Manager daemon (via the EMAPI) and between resource monitors and the Event Manager daemon (via the RMAPI).

Intra-Domain Port Numbers

For communication between Event Manager daemons within a domain, the Event Management subsystem uses a single UDP port number. This port number is recorded in the **Syspar_ports** SDR class. The class contains two attributes: **subsystem** and **port**. The class object whose **subsystem** attribute has a value of **haem** contains the port number for the Event Management subsystem. Note that the **Syspar_ports** class is a partitioned SDR class, that is, there is a set of objects for each system partition. When you configure the Event Management subsystem for a particular domain, you use the SDR data that corresponds to that domain, that is, system partition.

The Event Management port number is stored in the SDR so that, when the Event Management subsystem is configured on each node, the port number is fetched from the SDR. This ensures that the same port number is used by all Event Manager daemons in the same domain. Note that because an Event Manager daemon from each domain runs on the control workstation, the Event Management subsystem in each domain must have a unique port number.

This intra-domain port number is also set in the **/etc/services** file, using the service name **haem.***domain_name*, where *domain_name* is the name of the domain. The **/etc/services** file is updated on all nodes in the domain and on the control workstation. The Event Manager daemon obtains the port number from the **/etc/services** file during initialization.

Remote Port Numbers

The Event Management subsystem also uses a single TCP port number to accept communications from clients outside its domain. All Event Manager daemons that run on the control workstation use this port number to accept connections from EM clients outside their respective domains. Each daemon binds to a distinct IP address that is the IP address of its system partition.

The TCP port number is stored in the **SP_ports** SDR system class. The class contains the **daemon**, **hostname**, and **port** attributes. The class object whose **daemon** attribute has a value of **haemd** contains the port number for the Event Management subsystem(s). The **hostname** attribute is not used in this object.

This remote port number is also set in the **/etc/services** file on the control workstation, using the service name **haemd**.

Unix Domain Sockets

Unix domain sockets are used for communication:

- Between EM clients and the local Event Manager daemon (via the EMAPI)
- Between resource monitors and the Event Manager daemon (via the RMAPI).

These are connection-oriented sockets. The following socket names are used (*domain_name* is the name of the domain):

/var/ha/soc/em.clsrv.*domain_name*
Used by the EMAPI to connect to the Event Manager daemon.

/var/ha/soc/em.rmsrv.*domain_name*
Used by resource monitors to connect to the Event Manager daemon.

/var/ha/soc/haem/em.RM*rmname***.***rminst***.***domain_name*
Used by the Event Management daemon to connect to the resource monitor that is specified by *rmname* and *rminst*, where *rmname* is the resource monitor name and *.rminst* is the resource monitor instance number. This resource monitor has a connection type of **server**.

Configuration Data

Configuration information for the Event Management subsystem is stored in the SDR as objects in the following classes:

EM_Resource_Variable
Contains the definitions of all resource variables. The resources with which these variables are associated are implied in the definitions.

EM_Resource_ID
Contains the definitions of all of the resource IDs that are associated with the resources that are specified in the **EM_Resource_Variable** class.

EM_Structured_Byte_String
Contains the definitions of the structured fields for all resource variables that have a data type of structured byte string (SBS).

EM_Resource_Class
Contains the definitions for the resource classes with which each resource variable is associated.

EM_Resource_Monitor
Contains the definitions for all resource monitors.

For details about the Event Management SDR classes and attributes, see *Event Management Programming Guide and Reference*.

These SDR classes are partitioned classes. Therefore, each Event Management subsystem domain has its own configuration data. This permits a different set of resources to be monitored in each domain, as appropriate for the workload within the domain.

The Event Management SDR objects are loaded from the default configuration data when the Event Management subsystem is added to a domain using the control script.

There are several attributes that you, as the system administrator, may wish to change. They are:

- The **rvExpression** attribute of the **EM_Resource_Variable** class

Change this attribute to add or replace a default expression for a resource variable.

- The **rcObservation_interval** attribute of the **EM_Resource_Class**.

  Change this attribute to increase or decrease the time between observations of a resource variable value by the Event Manager daemon.

For more information, see “Changing Configuration Data in the SDR” on page 402.

If resource monitors supplied by other IBM products or by third parties are installed on the SP system, you must load the configuration data supplied with the resource monitors into the SDR. For more information, see “Loading Non-PSSP Configuration Data into the SDR” on page 401.

The Configuration Utility (haemcfg)

The Event Management configuration utility is contained in the executable file **/usr/sbin/rsct/bin/haemcfg**. This utility is normally run on the control workstation in the environment of a system partition, that is, the value of the **SP_NAME** environment variable determines the partitioned SDR classes that are referenced. If **SP_NAME** is not set, the default system partition is assumed. Recall that a domain is equivalent to a system partition.

The **haemcfg** command converts the data stored in the Event Management SDR classes to a binary format called the Event Management Configuration Database (EMCDB). The EMCDB is placed in the staging file called **/spdata/sys1/ha/cfg/em.***domain_name***.cdb**, where *domain_name* is the name of the domain in which the utility is run.

A version string that uniquely identifies the EMCDB is placed both in the EMCDB itself and in the **Syspar** partitioned SDR class. The version string is set as the value of the **haem_cdb_version** attribute in the object whose **syspar_name** attribute value matches the current system partition. The version string is used to ensure that all of the Event Manager daemons and resource monitors that are running within the domain are using the same copy of the EMCDB.

If a previous copy of the **em.***domain_name***.cdb** file exists, it is renamed to **/spdata/sys1/ha/cfg/em.***domain_name***.cdb.***ssss,nnnn,v*, where *ssss,nnnn,v* is the version string of the previous copy.

The **haemcfg** command is automatically invoked by the control script when the Event Management subsystem is added to a domain.

For details on the **haemcfg** command, see *PSSP Command and Technical Reference*.

The Configuration Database (EMCDB)

The Event Management Configuration Database (EMCDB) is produced by the **haemcfg** command from the information in the SDR. The format of the EMCDB is designed to permit quick loading of the database by the Event Manager daemon and the RMAPI. It also contains configuration data in an optimized format to minimize the amount of data that must be sent between Event Manager daemons and between an Event Manager daemon and its resource monitors.

When the SDR data is compiled, the EMCDB is placed in a staging file. When the Event Manager daemon on a node or the control workstation initializes, it automatically copies the EMCDB from the staging file to a run-time file on the node or the control workstation. The run-time file is called **/etc/ha/cfg/em.***domain_name***.cdb**, where *domain_name* is the name of the domain.

For more information, see "Reading the EMCDB" on page 393.

The Control Script (haemctrl)

The Event Management control script is contained in the executable file **/usr/sbin/rsct/bin/haemctrl**. This script is normally invoked by the **syspar_ctrl** script, which provides an interface to all of the system partition-sensitive subsystems.

If necessary, you can invoke **haemctrl** directly from the command line. Note that before you invoke **haemctrl**, you must ensure that the **SP_NAME** environment variable is set to the appropriate system partition name.

For more information about **haemctrl** and **syspar_ctrl**, see *PSSP Command and Technical Reference*.

The purpose of the **haemctrl** command is to add (configure) the Event Management subsystem to a domain. It can also be used to remove the subsystem from a domain, start the subsystem, stop it, and clean the subsystem from all domains.

For more information, see "Configuring Event Management" on page 389.

The Configuration Load Utility (haemloadcfg)

The configuration load utility is contained in the executable file **/usr/sbin/rsct/install/bin/haemloadcfg**. The purpose of this program is to load the default configuration data into the SDR. Normally, it is invoked by the **haemctrl** script, but you can also use it to load additional configuration data into the SDR. Note that before you invoke **haemloadcfg**, you must ensure that the **SP_NAME** environment variable is set to the appropriate system partition name.

By default, this utility does not replace existing objects in the SDR. Input data is matched with existing objects based on key attributes. The key attributes for each of the Event Management SDR classes are:

SDR Class	Key Attributes
EM_Resource_Variable	**rvName**
EM_Resource_ID	**riResource_name**, **riElement_name**
EM_Structured_Byte_String	**sbsVariable_name**, **sbsField_name**
EM_Resource_Class	**rcClass**
EM_Resource_Monitor	**rmName**

Note that the way in which the **haemloadcfg** command handles existing SDR objects is different from the way in which the **SDRCreateObjects** command handles them. The **SDRCreateObjects** command creates a new object as long as the attributes, taken as a group, are unique.

The **haemloadcfg** command is actually a shell script that invokes the **/usr/sbin/rsct/bin/loadsdr** program. The purpose of this program is to batch load any number of objects into SDR classes. However, the **loadsdr** command cannot load arbitrary SDR classes. It can load only the Event Management SDR classes.

In this release of Event Management subsystem, the **EM_Resource_ID** SDR class replaces the **EM_Instance_Vector** class from prior releases. In the **EM_Resource_Variable** SDR class, the **rvExpression** and **rvIndex_element** attributes replace the **rvPredicate** and **rvIndex_vector** attributes, respectively. The **loadsdr** program automatically migrates SDR data that may be present from prior releases to the new forms.

The Default Configuration Data (haemloadlist)

The default Event Management configuration data for PSSP is supplied in the **/usr/sbin/rsct/install/config/haemloadlist** file. The data in this file is loaded into each system partition to which the Event Management subsystem is added by the **haemctrl** script, using the **haemloadcfg** command.

Files and Directories

The Event Management subsystem uses the following directories:

- **/var/ha/lck**, for lock files
- **/var/ha/log**, for log files
- **/var/ha/run**, for Event Manager daemon current working directories
- **/var/ha/soc**, for socket files
- **/etc/ha/cfg**, for run-time EMCDB and related files
- **/spdata/sys1/ha/cfg**, as the staging area for EMCDB files.

The /var/ha/lck Directory (Lock Files)

In the **/var/ha/lck/haem** directory, the **em.RM***rmname***.***domain_name* file is used to manage one or more running instances of a resource monitor. In this file name, *rmname* is the name of the resource monitor and *domain_name* is the name of the domain.

The **em.RM***rmname.rminst***SHM**.*domain_name* file in the **/var/ha/lck** directory is used by the Event Management daemon to manage a shared memory segment used by the daemon and resource monitor instance specified by *rmname* and *rminst* where *rmname* is the resource monitor name and *rminst* is the resource monitor instance number. The file contains the shared memory segment ID.

The **em.haemd.***domain_name* file in the **/var/ha/lck** directory is used to ensure a single running instance of an Event Manager daemon in a domain.

The **em.RM***rmname***SPMI** file in the **/var/ha/lck** directory is used by the RMAPI to create a shared memory key when the resource monitor attaches to the shared memory segment managed by the SPMI library.

The /var/ha/log Directory (Log Files)

In the **/var/ha/log** directory, the **em.trace.***domain_name* file contains trace output from the Event Manager daemon. In the file name, *domain_name* is the name of the domain.

The **em.msgtrace.***domain_name* file contains message trace output from the Event Manager daemon.

The **em.default.***domain_name* file contains any error messages from the Event Manager daemon that cannot be written to the AIX Error Log. Normally, all daemon error messages are written to the AIX Error Log.

In addition to error messages that cannot be written to the AIX Error Log, the **/var/ha/log/em.default.***domain_name* file also contains error messages that result from repetitive operational errors. Therefore, both the AIX Error Log and the **/var/ha/log/em.default.***domain_name* file must be examined when performing problem determination on the Event Management subsystem.

The size of the **/var/ha/log/em.default.***domain_name* file is examined every two minutes. If the size of the file exceeds 256K, the file is renamed to **/var/ha/log/em.default.***domain_name***.last** and a new default file is created. No more than two copies of this file are kept: the “current” **em.default.***domain_name* file and the “last” file.

The **/var/ha/log/em.default**.*domain_name.n* file is used to record additional error information if the Event Manager daemon cannot start a resource monitor. The error information includes the name of the resource monitor that could not be started.

The /var/ha/run Directory (Daemon Working Files)

In the **/var/ha/run** directory, a directory called **haem.***domain_name* is created, where *domain_name* is the domain name. This directory is the current working directory for the Event Manager daemon. If the Event Manager daemon abnormally terminates, the core dump file is placed in this directory. Whenever the Event Manager daemon starts, it renames any core file to **core.last**.

If the Event Manager daemon detects an error in the shared memory segment used by the daemon and a resource monitor instance, it creates a dump file containing the first 4096 bytes of the shared memory segment in this directory. The dump file is named **rzdump.RM***rmname.rminst.time* where *rmname* is the resource monitor name, *rminst* is the resource monitor instance, and *time* is the time stamp.

This directory also contains the working directories of any resource monitors that are started by the Event Manager daemon. Each directory has the name of its resource monitor.

Finally, this directory contains the **Rcache_local** and **Rcache_remote** directories. These directories contain the registration cache for local and remote client registration requests, respectively.

For each EM client that establishes communications with the Event Manager daemon, a cache subdirectory is created in the appropriate registration cache directory. This subdirectory has a name of the form *p,s,n,q,i*, where:

- *p* is the process ID of the EM client

- *s* is the seconds portion of the timestamp recorded when the EM client established its session with the Event Manager daemon
- *n* is the nanoseconds portion of the timestamp
- *q* is a sequence number for the session
- *i* is the IP address of the host where the EM client is running. For local clients, the IP address is 0.0.0.0.

Within each subdirectory are several files with numeric names. Each file contains a registration request. The file name is the event command group ID of the group of events within the request.

The /etc/ha/cfg Directory (Run-Time EMCDB and Related Files)

The **/etc/ha/cfg** directory contains the run-time EMCDB file for each system partition. The file is called **/etc/ha/cfg/em.***domain_name***.cdb**, where *domain_name* is the name of the domain.

In addition, there is a file called **em.***domain_name***.cdb_vers**, where *domain_name* is the name of the domain. This file is created by the Event Manager daemon and contains the version string of the EMCDB file used by the daemon. This file is also used by the RMAPI to ensure that it is using the same EMCDB as the Event Manager daemon.

Components on Which Event Management Depends

The Event Management subsystem depends on the following components:

SPMI	The System Performance Monitor Interface (SPMI) is a library that is included with AIX (in the perfagent.tools file set). This library is used by the RMAPI and the **aixos** resource monitor.
Group Services	Another RSCT subsystem. It provides high availability membership services for coordinating activities on multiple nodes that are used by the Event Management subsystem.
System Data Repository (SDR)	A repository of SP system configuration information that includes the configuration information for the Event Management subsystem.

The sections that follow contain more details about each of these components.

The System Performance Monitor Interface (SPMI) Library

The System Performance Monitor Interface (SPMI) library resides at **/usr/lib/libSpmi.a**. The RMAPI uses the shared memory technology of this library to deliver resource variable values to the Performance Toolbox for AIX product and the Performance Toolbox Parallel Extensions (PTPE) optional feature of PSSP. Thus, a resource monitor supplies data not only for event management, but also for performance monitoring.

Also, the **aixos** resource monitor uses the SPMI to obtain AIX operating system statistics that are the source of the AIX operating system resource variables that are supplied by RSCT.

The Group Services Subsystem

The Group Services subsystem provides another set of high availability services. The Event Management subsystem primarily uses Group Services to monitor the state of each Event Manager daemon in the domain, as follows. Each Event Manager daemon in the domain joins a Group Services group called **ha_em_peers**. Group Services informs each Event Manager daemon, in a synchronized fashion, when a daemon has joined or left the group.

Associated with the **ha_em_peers** group is a group state that contains the version string of the EMCDB. Thus, when an Event Manager daemon joins the **ha_em_peers** group, it can determine the version of the EMCDB that the rest of the group is using.

The Event Manager daemon also subscribes to the **HostMembership**, **enMembership**, and **cssMembership** system groups. Instances of the **IBM.PSSP.Membership.Node.state** resource variable are derived from **HostMembership** group information. Instances of the **IBM.PSSP.Membership.LANAdapter.state** resource variable are derived from **enMembership** and **cssMembership** group information. Instance of the **IBM.PSSP.Response.Host.state** resource variable are derived from **enMembership** group information.

The System Data Repository (SDR)

The Event Manager daemon uses the SDR primarily as a repository of configuration information. In addition, on the control workstation, the Event Manager daemon polls the SDR for information that it uses to create instances of the **IBM.PSSP.Response.Switch.state** resource variable. This information is taken from the **switch_responds** SDR class.

Configuring and Operating Event Management

The following sections describe how the components of the Event Management subsystem work together to provide event management services. Included are discussions of:

- Event Management configuration
- Event Manager daemon initialization
- Event Management operation.

Configuring Event Management

RSCT is installed as part of the installation of the PSSP product. The Event Management subsystem is contained in the **rsct.basic.rte** and **rsct.basic.sp** filesets. The EMAPI libraries are contained in the **rsct.clients.rte** and **rsct.clients.sp** filesets.

After the components are installed, the subsystem must be configured for operation. Event Management configuration is performed by the **haemctrl** command, which is invoked by the **syspar_ctrl** command.

The **syspar_ctrl** command configures all of the system partition-sensitive subsystems. The person who installs PSSP issues the **syspar_ctrl** command during installation of the control workstation. The **syspar_ctrl** command is executed automatically on the nodes when the nodes are installed. The **syspar_ctrl** command is also executed automatically when system partitions are created or destroyed. For more information on using the **syspar_ctrl** command, see *PSSP Installation and Migration Guide* and *PSSP Command and Technical Reference*.

The **haemctrl** command provides a number of functions for controlling the operation of the Event Management system. You can use it to:

- Add (configure) the Event Management subsystem
- Start the subsystem
- Stop the subsystem
- Delete the subsystem
- "Clean" all Event Management subsystems
- "Unconfigure" all Event Management subsystems
- Turn tracing of the Event Manager daemon on or off
- Refresh the Event Management subsystem

Except for the clean and unconfigure function, **haemctrl** affects the Event Management subsystem in the current system partition, that is, the system partition that is specified by the **SP_NAME** environment variable.

Adding the Subsystem

If the **haemctrl** command is running on the control workstation, the first step in the add function is to select an Event Manager daemon communications port number and save it in the **Syspar_ports** SDR class. This port number is then placed in the **/etc/services** file. If the **haemctrl** command is running on a node, the port number is fetched from the SDR and placed in the **/etc/services** file. Port numbers are selected from the range 10000 through 10100.

The second step is to add the Event Management startup program to the System Resource Controller (SRC) using the **mkssys** command. On the control workstation, the IP address of the system partition is an argument to the **haemd_SP** program in the SRC subsystem specification. The third step is to add the **aixos** resource monitor daemon **harmad** to the SRC using the **mkssys** command.

The fourth step is to add an entry to the **/etc/inittab** file so that the Event Manager daemon and the **aixos** resource monitor will be started during boot. However, if **haemctrl** is running on a High Availability Control Workstation (HACWS), no entry is made in the **/etc/inittab** file. Instead, HACWS manages starting and stopping the Event Manager daemon and the **aixos** resource monitor.

The remaining steps in the add function are performed only on the control workstation. The **haemloadcfg** program is run to load the default configuration data into the SDR. The **haemcfg** command is run to create the EMCDB and place it into the staging directory. Finally, if it is not already stored in the SDR, an Event Manager daemon remote client communications port number is selected from the range 10000 through 10100. This port number is then placed in the **/etc/services** file. This port number is used by all of the Event Manager daemons on the control workstation.

Note that if the **haemctrl** add function terminates with an error, the command can be rerun after the problem is fixed. The command takes into account any steps that already completed successfully.

Starting and Stopping the Subsystem

The start and stop functions of the **haemctrl** command simply run the **startsrc** and **stopsrc** commands, respectively. However, **haemctrl** automatically specifies the subsystem argument to these SRC commands.

Deleting the Subsystem

The delete function of the **haemctrl** command removes the subsystem from the SRC, removes the entry from **/etc/inittab**, and removes the Event Manager daemon communications port number from **/etc/services**. It does **not** remove anything from the SDR, because the Event Management subsystem may still be configured on other nodes in the domain.

Cleaning the Subsystem

The clean function of the **haemctrl** command performs the same function as the delete function, except in all system partitions. In addition, it removes the Event Manager daemon remote client communications port number from the **/etc/services** file.

The clean function does **not** remove anything from the SDR. This function is provided to support restoring the system to a known state, where the known state is the (possibly restored copy of the) SDR database.

Unconfiguring the Subsystem

The unconfigure function of the **haemctrl** command performs the same function as the clean function and then removes all port numbers from the SDR allocated by the Event Management subystem. This function can only be performed on the control workstation and must be preceded by executing the clean function of the **haemctrl** command on all of the nodes.

The purpose of this function is to remove allocated port numbers from the SDR in a consistent manner.

Tracing the Subsystem

The tracing function of the **haemctrl** command is provided to supply additional problem determination information when it is requested by the IBM Support Center. Normally, tracing should **not** be turned on, because it may slightly degrade Event Management subsystem performance and can consume large amounts of disk space in the **/var** file system.

Refreshing the Subsystem

The refresh function of the **haemctrl** command initiates a procedure in the Event Management subsystem to refresh the subsystem's security configuration. The security configuration is modified to use the current SP Trusted Services authentication methods. See "Understanding Event Management Security" on page 395.

Initializing Event Manager Daemon

Normally, the Event Manager daemon startup program, **haemd_SP**, is started by an entry in the **/etc/inittab** file using the **startsrc** command. If necessary, you can start the startup program using the **haemctrl** command or the **startsrc** command directly. The startup program performs the following steps:

1. It gets the number of the node where it is running using the **/usr/lpp/ssp/install/bin/node_number** command. Node 0 is the control workstation.
2. It fetches the name of the system partition and the EMCDB version string from the **Syspar** SDR class. (Recall that one instance of the Event Manager daemon runs on the control workstation for each system partition to which the Event Management subsystem was added.) It also fetches the Event Manager daemon remote client communications port number from the **SP_ports** SDR class.
3. Finally, the startup program invokes the Event Manager program **haemd**, passing the information just collected and any arguments passed to the startup program itself. Note that a new process is not started; the process image is just replaced. This permits the Event Manager daemon to be controlled by the SRC. During its initialization, the Event Manager program performs the following steps:
   a. It performs actions that are necessary to become a daemon. This includes establishing communications with the SRC subsystem so that it can return status in response to SRC commands.
   b. It removes from the registration cache, all of the subdirectories for local EM clients that no longer exist. That is, if the process ID in the subdirectory name cannot be found, it removes the subdirectory.

      Note that subdirectories for remote clients cannot be removed automatically, because the Event Manager daemon cannot determine if remote processes still exist.
   c. It tries to connect to the Group Services subsystem. If the connection cannot be established because the Group Services subsystem is not running, it is scheduled to be retried in 5 seconds. This continues until the connection to Group Services is established. Meanwhile, Event Manager daemon initialization continues.
   d. It enters the main control loop.

      In this loop, the Event Manager daemon waits for requests from EM clients, messages from resource monitors and other Event Manager daemons, messages from the Group Services subsystem, and requests from the SRC for status. It also waits for internal signals that indicate a function that was previously scheduled should now be executed, for example, retrying a connection to Group Services.

      However, EM client requests, messages from resource monitors, and messages from other Event Manager daemons (called peers) are refused until the Event Manager daemon has successfully joined the daemon peer group (the **ha_em_peers** group) and has fetched the correct version of the EMCDB.

Joining the Peer Group

After the Event Manager daemon has successfully established a connection with the Group Services subsystem, it tries to join the daemon peer group, a Group Services group called **ha_em_peers**. If this is the first Event Manager daemon to come up in the domain, it establishes the peer group. Otherwise, the other daemons in the peer group either accept or reject the daemon's join request. If an existing peer group member is still recovering from a prior termination of the joining daemon, the join request is rejected. If its join request is rejected, the daemon tries to join again in 15 seconds. This continues until the daemon's join request is accepted.

When it joins the daemon peer group, the Event Manager daemon examines the group state. The group state is the EMCDB version string.

If the group state is null, the joining daemon proposes that the group state be set to the version string that the daemon has fetched from the SDR. If several daemons try to join the group at about the same time, and the group state is null, then each daemon proposes the group state. When the group is formed, Group Services selects one of the proposals and sets the group state to it. Note that each daemon is proposing the EMCDB version string that it has fetched from the SDR. Unless the **haemcfg** command has been run at about the same time, the proposed version strings should be identical.

If the group state is not null when it is examined by the joining daemon, a group has already formed and the daemon does **not** propose a new group state.

After the daemon has successfully joined the peer group, it compares the EMCDB version string contained in the group state to the version string it fetched from the SDR. If they are different, the version that was fetched from the SDR is replaced by the version in the group state.

An Event Manager daemon is prevented from joining the peer group as long as any other Event Manager daemon, currently in the peer group, is non-responsive to “pings” from the Group Services subsystem. (When an Event Manager daemon successfully joins the peer group, Group Services requests a response from the Event Manager daemon every two minutes. If the daemon does not respond to the request within two minutes, it is considered to be non-responsive. A daemon is also considered to be non-responsive if it does not reply to the join requests of other daemons within one minute.) The Event Manager daemon status, as displayed by the **lssrc** command, indicates if a daemon cannot join the peer group. If this is the case, the **em.default.***domain_name* file of any other daemon in the peer group should be examined for errors indicating that an Event Manager daemon is non-responsive. If so, and the non-responsive daemon does not terminate itself within a few minutes, perform the User Response specified for the error.

Reading the EMCDB

Once the daemon has joined the peer group and has determined the EMCDB version, it reads the run-time EMCDB file from the **/etc/ha/cfg** directory. If the file does not exist, it is copied from the staging directory on the control workstation.

Once the daemon has read the file, it compares the version string in the EMCDB to the one it fetched (from the SDR or from the group state). If the two version strings do not match, and the daemon has not just copied the EMCDB from the control workstation, then it copies the run-time EMCDB from the control workstation. If the version strings still do not match, the daemon terminates with an error.

Whenever it is necessary to copy the EMCDB from the control workstation, the EMCDB version string is used to determine how the copy is done. If the EMCDB version string was obtained from the group state then it is used to copy a back level EMCDB from the staging directory on the control workstation. Otherwise, the staging file **/spdata/sys1/ha/cfg/em.***domain_name***.cdb** is copied. Note that back level copies of the EMCDB should be removed from the staging directory only if their version string suffix indicates a time stamp older than the current version string found in the daemon peer group state (the current version string is found in the Event Manager daemon status, as displayed by the **lssrc** command. See "Displaying the Status of the Event Manager Daemon" on page 399.

After the daemon has read and validated the EMCDB, it enables daemon communications. This permits EM clients to send requests to the daemon, resource monitors to connect to the daemon, and peers to send messages to the daemon. At this point, the initialization of the Event Manager daemon is complete.

To copy the EMCDB from the control workstation to the **/etc/ha/cfg** directory, the Event Manager daemon uses the **/usr/sbin/rsct/install/bin/haemrcpcdb** script. This script uses the **rcp** command to perform the actual copy.

The way in which Event Manager daemons determine the EMCDB version has important implications for the configuration of the subsystem. To place a new version of the EMCDB into production (that is, to make it the run-time version that is used by the Event Management subsystem), you must stop each Event Manager daemon in the domain after the **haemcfg** command is run. Stopping the daemons dissolves the existing peer group. Once the existing peer group is dissolved, the daemons can be restarted. As they restart, the daemons form a new peer group. A new EMCDB version string can be submitted as the group state only when a peer group is formed.

Operating the Event Management Daemon

Normal operation of the Event Management subsystem requires no administrative intervention. The subsystem recovers from temporary failures automatically. However, there are some characteristics that may be of interest to administrators.

For performance reasons, the Event Manager daemon has an internal limit of 256 open file descriptors. In practice, this limits the number of EM client sessions, either local or remote, to about 225. This file descriptor limit is per daemon; it does not limit the number of EM clients in the domain.

The Event Manager daemon connects to a resource monitor of type **server** as the resource monitor starts. If a server resource monitor is running prior to the start of the Event Manager daemon, the daemon connects to the resource monitor after enabling daemon communications. If able, the daemon starts a **server** resource monitor when necessary. However, connection and start attempts are constrained under the following circumstances:

1. If it is necessary that the daemon start the resource monitor before each connection attempt, then after three attempts within two hours the resource monitor is "locked" and no further attempts are made.

2. If the resource monitor is not startable by the Event Manager daemon, then after about three successful connections within two hours the resource monitor is “locked” and no further attempts are made.

The rationale for locking the resource monitor is that, if it cannot be started and stay running or successful connections are frequently being lost, then a problem exists with the resource monitor. Once the problem has been determined and corrected, the **haemunlkrm** command can be used to unlock the resource monitor and connect to it, starting it first if necessary. Note that locking does not apply to **client** type resource monitors.

The primary function of the Event Manager daemon is to generate events, by observing resource variable values and applying expressions to those values. However, this function is performed for a resource variable only if an EM client has registered to receive events for that resource variable. The Event Manager daemon also observes a resource variable once to satisfy a query request, if the resource variable is not already being observed. When observations are necessary, the Event Manager daemon commands the appropriate resource monitor (if it has a connection type of **server**) to supply resource variable values. When observations are no longer necessary, the Event Manager daemon commands the resource monitor to stop supplying values. In this way, the Event Manager daemon performs no action for resource variables that are not of interest to clients.

Even if a resource monitor that has a connection type of **server** is running, it does not supply data to the Event Manager daemon except by command of the daemon.

The Event Manager daemon either observes a resource variable located in shared memory every X seconds, where X is the observation interval that is specified in the resource variable's resource class definition, or when the resource variable's value is sent to the Event Manager daemon by the resource monitor (transparently, via the RMAPI). The values of resource variables of value type Counter and Quantity are located in shared memory. The values of resource variables of value type State are not.

All resource variables that are located in shared memory with the same observation interval are observed on the same time boundary. This minimizes the observation overhead, no matter when the request for a resource variable is made.

Understanding Event Management Security

The Event Management subsystem provided in RSCT 1.2, which is installed with PSSP 3.2, is an SP trusted service. Event Management enforces the security policies as defined by the trusted services authentication methods configured in the domain (SP system partition) in which the Event Management subsystem is running. These authentication methods can be any combination of DCE, compatibility, and none.

Authentication and Authorization of EM Clients

Table 16 on page 396 defines the behavior of an EM client and the EM daemon to which it connects for each combination of authentication methods. Since an EM client may not be on the same node as the EM daemon to which it connects, the table includes entries for each possible combination of authentication methods configured on the node where the EM client and the EM daemon are running. Each table column represents a combination of authentication methods for the EM daemon and each table row represents a combination of authentication methods for the EM client.

Table 16. Behavior of the Event Management subsystem with respect to trusted service authentication methods.

EM Client	EM Daemon				
	DCE	**DCE and Compat**	**Compat**	**None**	**No support**
DCE	MutualAuth	MutualAuth	Error	Error	Error
DCE and Compat	ClientAuth	OK	OK	OK	OK
Compat	Error	OK	OK	OK	OK
None	Error	OK	OK	OK	OK
No support	Error	OK	OK	OK	Not applicable

The row and column headings have the following meanings:

DCE Only the DCE authentication method is configured on the node.

DCE and Compat Both the DCE and compatibility authentication methods are configured on the node.

Compat Only the compatibility authentication method is configured on the node.

None Neither the DCE nor the compatibility authentication methods are configured on the node.

No support The node is installed with an earlier version than PSSP 3.2.

The table cell labels have the following meanings:

MutualAuth For the combination of authentication methods that intersect in a table cell with this label, the EM daemon authenticates the DCE principal under which the EM client is running and then the EM client authenticates the DCE principal under which the EM daemon is running. This mutual authentication ensures that both the EM daemon and the EM client recognize the identity of the other.

ClientAuth For the combination of authentication methods that intersect in the table cell with this label, the EM daemon authenticates the DCE principal under which the EM client is running; the EM client does no authentication of the EM daemon.

Error For the combination of authentication methods that intersect in a table cell with this label, no communication is permitted between the EM client and the EM daemon.

OK For the combination of authentication methods that intersect in a table cell labeled OK, communication is always permitted: the EM client is unauthenticated.

Whenever an EM client is authenticated by the EM daemon, the DCE principal that is executing the client must also by defined in the Event Management DCE group named **haem-users**. The access control policy of the Event Management subsystem is that an authenticated EM client must be a member of the DCE group **haem-users** in order to access the Event Management subsystem and the resources which it monitors. When communication between an unauthenticated EM client and an EM daemon is permitted, no additional authorization is required.

Note: The name **haem-users** is the default group name. That name can be changed locally by the system administrator. If it is locally changed, remember to replace the name **haem-users** with your local group name wherever it appears in the documentation.

All authentication and authorization logic is implemented in the EMAPI library and the EM daemon. This logic is executed whenever an EM client application attempts to start a session with the Event Management subsystem. Errors in authentication, authorization, or an invalid combination of authentication methods between the EM client and the EM daemon, as indicated by the label Error in Table 16 on page 396, result in a failure of the request to start the EM session.

Security and the Peer Group

Each EM daemon has a security state that matches the SP trusted services authentication methods configured on the node where the daemon is running. The states are the following:

DCE
DCE and Compatibility
Compatibility
None
No support

The EM peer group also has a security state, as maintained in the peer group state value as one of the following three keywords:

SEC	Security is enabled in the peer group.
NOSEC	Security is disabled in the peer group.
NOSECSUPPORT	No security is supported in the peer group.

The security state of each EM daemon in the peer group must match that of the peer group as defined in Table 17.

Table 17. Daemon and Peer Group Security States

EM daemon security state	EM peer group security state
DCE	SEC
DCE and Compat	NOSEC (or null)
Compat	NOSEC (or null)
None	NOSEC (or null)
No support	NOSECSUPPORT (or null)

If the peer group contains versions of EM daemons from earlier releases, then the peer group state value might not contain any of the keywords SEC, NOSEC, or

NOSECSUPPORT. The security state value might be null. The peer group state value can be observed by displaying the status of the EM daemon.

When the EM daemon starts, it determines if the node has been installed with PSSP 3.2. If not the security state of the daemon is *No support*. Otherwise, the daemon obtains the currently configured SP trusted services authentication methods and sets the respective security state. If the daemon cannot obtain the authentication methods, it sets the security state to *None*. When the daemon then joins the peer group, if the peer group currently has no state set, it proposes a peer group security state to match. Upon completion of the join, the daemon checks if the security states match. If they do not match as in Table 17 on page 397, the daemon logs an error and exits.

The result of this procedure is that the first daemon that joins the peer group sets the security state of the group, as defined on the node. If multiple daemons join the group at the same time, and the group does not currently exist, then Group Services arbitrarily picks one of the proposed group states. This can result in one or more daemons exiting with an error if their proposed state is not the one picked. This can only occur if the nodes where the daemons are executing do not all have compatible security configurations, as defined in Table 17 on page 397.

Effect of Migration or Changing Security Configuration

As indicated by the information in Table 16 on page 396 and Table 17 on page 397, the Event Management subsystem supports a mixture of authentication methods within a domain, including nodes where an EM client is executing outside of the domain. This permits the EM subsystem to support migration to PSSP 3.2 one node at a time.

After migration is complete, or any time the SP trusted services authentication methods are changed on the nodes of a domain, the Event Management subsystem needs to be refreshed. The refresh usually happens automatically by some task during migration and configuration. For instance, the **haemctrl -r** command is invoked automatically by the **chauthpts** command. If you ever need to, you can use the **haemctrl -r** command directly to refresh the subsystem. The daemon that receives the command to refresh obtains a new security state by obtaining the current authentication methods. It then proposes a peer group state change that matches this new state, as defined in Table 17 on page 397. When each daemon receives the proposal, it also obtains the current configuration methods on the node. If the latest methods match the proposed state, then the daemon votes ACCEPT, else it votes REJECT. If the protocol is approved by all daemons then each daemon uses the security state just obtained. After the security state of the daemon is updated, the daemon checks all client connections to see if they have an appropriate security state according to Table 18 on page 399. If not, the connections are closed. When the client detects that its connection has terminated, it can do another start session or a restart session. In either case, authentication and authorization are once again performed according to the policy in Table 16 on page 396.

Table 18. Validation of EM Client Connection

Connection Authentication State	New EM Daemon Security Configurations			
	DCE	DCE and Compat	Compat	None
Auth	Keep	Keep	Keep	Keep
No Auth	Close	Keep	Keep	Keep

Table 18 shows the policy used to validate authorization of the EM client connection:

Auth	The client connection was authenticated when it was originally made (either MutualAuth or ClientAuth).
No Auth	The client connection is unauthenticated.
Keep	Keep the connection.
Close	Close the connection.

Event Management Procedures

For the most part the Event Management subsystem runs itself without requiring administrator intervention. However, on occasion, you may need to check the status of the subsystem, or add or change some of the configuration data.

This section contains the procedures that you need to do these tasks, which include:

- Displaying the status of the Event Manager daemon
- Loading non-PSSP configuration data into the SDR
- Changing configuration data in the SDR
- Activating the configuration data in the SDR
- Changing resource variable instance limits

Displaying the Status of the Event Manager Daemon

You can display the operational status of the Event Manager daemon by issuing the **lssrc** command.

On the control workstation, enter:

```
lssrc -l -s haem.domain_name
```

where *domain_name* is the name of the domain of interest.

On a node, enter:

```
lssrc -l -s haem
```

In response, the **lssrc** command writes the status information to standard output. The information includes:

- The information provided by the **lssrc -s haem** command (short form)

- The names of any trace flags that are set

  For information on these flags, see the **haemtrcon** command in *PSSP Command and Technical Reference*.

- The EMCDB version string and an indication as to whether the version string is taken from the SDR or from the peer group state.
- The day and time the Event Manager daemon was started.
- A report on the daemon's progress through initialization:

```
Daemon connected to group services: TRUE/FALSE
Daemon has joined peer group:       TRUE/FALSE
Daemon communications enabled :     TRUE/FALSE
```

- The security state of the daemon.
- A count of the peer daemons that are currently in the peer group. The count does not include this daemon.
- A listing of the peer group state.

  The peer group state includes the EMCDB version string and the peer group security state. The peer group security state is the keyword SEC, NOSEC, or NOSECSUPPORT. The keyword might have a suffix, but it can be ignored. If the peer group is established by a pre-PSSP 3.2 version of the EM daemon, no security keyword is present.

- The number and type of EM client connections. Note that when a daemon relays a request to another daemon, the sending daemon is treated as a client by the receiving daemon.
- A list of each resource monitor that is defined in the EMCDB and the current status of each, as follows.

  A resource monitor may have multiple executing instances, the number of the resource monitor instance is specified in the **Inst** column. The connection type (C=client, S=server, I=internal) is found in the **Type** column. The connection status is indicated by the **FD** column; if the file descriptor is greater than or equal to 0, a connection is open. If a resource monitor has a shared memory segment used to transfer information to the Event Manager daemon, it has a shared memory ID greater than or equal to 0 in the **SHMID** column. The process ID of the resource monitor is listed in the PID column; it is interpreted as follows:

ID greater than 0	Resource monitor has been successfully started by the Event Manager daemon
ID equal to 0	A resource monitor started by the daemon has terminated (or the resource monitor forked, the parent process exited and the child process is the actual resource monitor)
ID equal to -1	The resource monitor has never been started by the Event Manager daemon
ID equal to -2	The resource monitor is not startable by the Event Manager daemon.

  The **Locked** column indicates whether or not a resource monitor is locked and the current count of start attempts and successful connections, in the form *mm/nn*, where *mm* is the count of start attempts and *nn* is the count of successful connections.

If a resource monitor has more than one instance, information is present in the **PID** and **Locked** columns only for instance number 0. However, the count of successful connections is for all instances of the resource monitor.

- The highest file descriptor in use.
- The peer daemon status.

  This lists the status of peer daemons by node number, in node number order. Note that this list only includes peer daemons that have joined the peer group since the local daemon started.

  Following the node number are two characters. If both characters are **S**, the specified node is the number of the node where this daemon is running. Otherwise, the characters can take on values as follows.

  The first character is **I** or **O** where:

  – **I** indicates that the peer on the specified node is a peer group member.

  – **O** indicates that the peer is no longer a peer group member (but was at one time).

  The second character is either **A** or **R**, where:

  – **A** indicates that this daemon is accepting join requests from the peer on the specified node.

  – **R** means this daemon is rejecting join requests.

- A list of internal daemon counters, for use by IBM service personnel.

Loading Non-PSSP Configuration Data into the SDR

The default configuration data supplied for the PSSP is normally loaded into the SDR and compiled into its binary format automatically by the **haemctrl** script. However, if resource monitors supplied by other IBM products or by third parties are installed on the SP system, you must load the configuration data supplied with the resource monitors into the SDR and activate it. To do this:

1. Login to the control workstation. Use an ID that has **root** authority.
2. Create a file in load list format with the data to be loaded, or identify the path name of the file that has been supplied.

   If you are creating a new file, use the format specified in the man page for the **haemloadlist** file.
3. Set the **SP_NAME** environment variable to the appropriate system partition name.
4. Load the data into the SDR using the **haemloadcfg** command. Enter:

   ```
   haemloadcfg new_loadlist
   ```

   where *new_loadlist* is the path name of the load list you previously created or identified.
5. Activate all of the Event Management data in the SDR, including your new data, using the procedure in “Activating the Configuration Data in the SDR” on page 402.

Changing Configuration Data in the SDR

With an optional flag, the **haemloadcfg** command can replace existing objects (identified by their key attributes) in the SDR. If you want to change an object that already exists, do the following:

1. Login to the control workstation. Use an ID that has **root** authority.
2. Change the object's attribute in the load list file.

   For PSSP configuration data, the default configuration data is in the **/usr/sbin/rsct/install/config/haemloadlist** file. You must copy this file to another file and make the changes in the copy. If you have non-PSSP or third-party resource monitors, the object will be loaded from another load list file.

   Do this step for as many objects as you are changing.
3. Set the **SP_NAME** environment variable to the appropriate system partition name.
4. Run the **haemloadcfg** command, specifying the **-r** flag and the changed load list file.

   In response, the **haemloadcfg** command replaces each object in the SDR matched by an object in the load list file.
5. Activate all of the Event Management data in the SDR, including your changed data, using the procedure in "Activating the Configuration Data in the SDR."

Activating the Configuration Data in the SDR

When you have added or changed the Event Management data in the SDR, you must activate it by recompiling the EMCDB and stopping and restarting the Event Manager daemons. To do this:

1. Login to the control workstation. Use an ID that has **root** authority.
2. Set the **SP_NAME** environment variable to the appropriate system partition name.
3. Recompile the EMCDB. Enter:

   ```
   haemcfg
   ```

   The output is placed in the staging directory in a file whose name indicates the system partition.
4. Stop the Event Manager daemons in this system partition.

   Issue the **haemctrl -k** command on the control workstation and on each of the nodes in the system partition.

   You can use the **dsh** or **Sysctl** commands to run the command on multiple nodes from the control workstation. For more information on using these commands, see "Using dsh to Run Parallel Management Commands" on page 99.
5. Verify that all of the Event Manager daemons in this system partition have stopped.

   On the control workstation, issue the **lssrc -s haem.***domain_name* command. On the nodes, issue the **lssrc -s haem** command.

You can use the **dsh** or **Sysctl** commands to run the command on multiple nodes from the control workstation. For more information on using these commands, see “Using dsh to Run Parallel Management Commands” on page 99.

The status of each daemon should indicate that it is inactive.

6. Restart the Event Manager daemons in this system partition.

   Issue the **haemctrl -s** command on the control workstation and on each of the nodes in the system partition.

   You can use the **dsh** or **Sysctl** commands to run the command on multiple nodes from the control workstation. For more information on using these commands, see “Using dsh to Run Parallel Management Commands” on page 99.

Changing Resource Variable Instance Limits

To change the limit on the number of resource variable instances accepted by the Event Management subsystem for any resource variable class, do the following:

1. Login to the control workstation. Use an ID that has **root** authority.
2. Set the **SP_NAME** environment variable to the appropriate system partition name.
3. Find the load list file that contains the resource variable class definition. Resource variable classes shipped for the PSSP are found in **/usr/sbin/rsct/install/config/haemloadlist**.
4. Find the class definition in the load list file. For example, the class definition of the Recoverable Virtual Shared Disk subsystem is:

```
EM_Resource_Class
        rcClass="IBM.PSSP.VSD"
        rcResource_monitor="IBM.PSSP.harmld"
        rcObservation_interval="60"
        rcReporting_interval="10"
```

5. Either modify the definition in the load list file or copy the definition to a new load list file (which will contain only the modified definition. This is required if the load list file is **/usr/sbin/rsct/install/config/haemloadlist**). Modify the definition by adding the attribute **rcInstance_limit** set to the desired value. For example, the Recoverable Virtual Shared Disk class definition would be changed to:

```
EM_Resource_Class
        rcClass="IBM.PSSP.VSD"
        rcResource_monitor="IBM.PSSP.harmld"
        rcObservation_interval="60"
        rcReporting_interval="10"
        rcInstance_limit="5000"
```

   to limit the number of Recoverable Virtual Shared Disk resource variable instances to 5000.

6. Execute the **haemloadcfg** command, specifying the **-r** flag and the name of the modified load list file.
7. Now, follow the procedure documented in “Activating the Configuration Data in the SDR” on page 402.

Chapter 27. Using the Problem Management Subsystem

The Problem Management subsystem (**pman**) provides an infrastructure for recognizing and acting on problem events in your SP system. This infrastructure is based on an Event Management application that provides configurable access to Event Management client and resource monitor function without the necessity of writing C programs that use the Event Management APIs.

For more information, see the book *RS/6000 SP High Availability Infrastructure*.

To understand the information presented in this chapter, you should be familiar with Event Management concepts and terminology. Some important Event Management terms are:

event	In Event Management, the notification that an expression evaluated to true. This evaluation occurs each time an instance of a resource variable is observed.
expression	In Event Management, the relational expression between a resource variable and other elements (such as constants or the previous value of an instance of the variable) that, when true, generates an event. An example of an expression is `X < 10` where X represents the resource variable `IBM.PSSP.aixos.PagSp.%totalfree` (the percentage of total free paging space). When the expression is true, that is, when the total free paging space is observed to be less than 10%, the Event Management subsystem generates an event to notify the appropriate application.
instance vector	An obsolete term replaced with the term **resource identifier**.
predicate	An obsolete term replaced with the term **expression**.
rearm expression	In Event Management, an expression used to generate an event that alternates with an original event expression in the following way: the event expression is used until it is true, then the rearm expression is used until it is true, then the event expression is used, and so on. The rearm expression is commonly the inverse of the event expression (for example, a resource variable is on or off). It can also be used with the event expression to define an upper and lower boundary for a condition of interest.
rearm predicate	An obsolete term replaced with the term **rearm expression**.
resource	In Event Management, an entity in the system that provides a set of services. Examples of resources include hardware entities such as processors, disk drives, memory, and adapters, and software entities such as database applications, processes, and file systems. Each resource in the system has one or more attributes that define the state of the resource.
resource identifier	In Event Management, a set of elements, where each element is a name/value pair of the form `name=value`, whose values uniquely identify the copy of the resource (and by extension, the copy of the resource variable) in the system.

resource monitor	A program that supplies information about the resources in the system. It can be a command, a daemon, or part of an application or subsystem that manages any type of system resource.
resource variable	In Event Management, the representation of an attribute of a resource. An example of a resource variable is `IBM.AIX.PagSp.%totalfree`, which represents the percentage of total free paging space. `IBM.AIX.PagSp` specifies the resource name and `%totalfree` specifies the resource attribute.

For more information on Event Management services, refer to *RSCT: Event Management Programming Guide and Reference*.

The major components of the Problem Management subsystem are:

- A Problem Management daemon (**pmand**) that provides access to events generated by Event Management on all nodes. In addition, the following function is provided to work in conjunction with **pmand**:
  - A command, **pmandef**, that provides for subscribing to Event Management events and associating actions for those events
  - A command, **pmanquery**, that queries the SDR for a description of a Problem Management subscription
  - A script, **pmandefaults**, that causes **pmand** to register for a set of default events
  - A script, **notify_event**, that mails an event notification when an event occurs
  - A script, **log_event**, that logs a record of an event to a regular wraparound file
- A resource monitor daemon, **pmanrmd**, that provides resource variables to Event Management. The following function is provided to work in conjunction with **pmanrmd**:
  - Sixteen resource variables. The resource variables are named **IBM.PSSP.pm.User_state1** through **IBM.PSSP.pm.User_state16**.
  - A command, **pmanrminput**, that provides for associating values with the sixteen supplied resource variables.
  - A sample file, **pmanrmd.conf**, for configuring the **pmanrmd** daemon.
  - A command, **pmanrmdloadSDR**, for loading the configuration information into the System Data Repository.

This chapter provides information on each of the components of Problem Management.

Understanding the Problem Management Daemon

The **pmand** daemon is a client of Event Management; it can be configured to register for Event Management events and perform actions when those events occur.

Event Management provides access to events throughout an SP system partition; therefore, **pmand** can monitor and react to events on the node on which it is running as well as on all other nodes in the system partition and the control workstation.

When you install your system, a **pmand** daemon is automatically configured on each node in a system partition. Additionally, there is a **pmand** daemon running on the control workstation for each system partition in the SP system. When running on a node, the **pmand** daemon:

- Monitors events occurring on the node on which the daemon is running
- Monitors events on all other nodes in the system partition
- Monitors events not associated with a node, such as frame events, as supplied by Event Management

There are no restrictions on what a **pmand** daemon can monitor:

- Any number of **pmand** daemons can monitor and act on a single event
- A single **pmand** daemon can monitor any number of events locally or remotely
- A single **pmand** daemon can monitor the same event multiple times and all the actions associated with all the event registrations are taken by the daemon when the event occurs

In Figure 40 **pmand** daemons are running on a 4 node SP system partition.

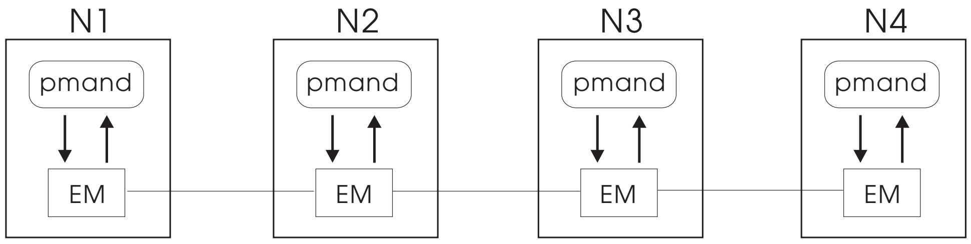


Figure 40. An Example of Problem Management Daemon Configuration

Each **pmand** daemon has access to events on the node on which it is running, as well as to the other nodes in the system partition. The access to the events is provided by Event Management, which is able, due to its distributed nature, to monitor resource variables throughout the system partition and to generate events based on the values of the resource variables. When an event that any of the daemons has subscribed to occurs (whether that event is local or remote), all the **pmand** daemons registered for it will perform the actions they are configured for (if any).

Because **pmand** is a daemon, its subscriptions to events are persistent. That is, the daemon continues to subscribe to events even after the process or user who created the subscription has gone away. A system administrator, for example, can set up automated operations with unattended monitoring and recovery actions.

Controlling pmand

The **pmand** daemon is under the System Resource Controller (SRC) and can be controlled by the following commands:

- To start **pmand** running, issue **startsrc -s** on a node.

  ```
  startsrc -s pman
  ```

  To start **pmand** running, issue **startsrc -s** on a control workstation.

  ```
  startsrc -s pman.system_partition_name
  ```

- To stop **pmand** running, issue **stopsrc -s** on a node.

  ```
  stopsrc -s pman
  ```

  To stop **pmand** running, issue **stopsrc -s** on a control workstation.

  ```
  stopsrc -s pman.system_partition_name
  ```

- To refresh **pmand**, issue **refresh -s**.

  ```
  refresh -s pman
  ```

  This causes **pmand** to update its internal configuration from the SDR and start pairing actions with events as specified by the **pmandef** command. If a **pmand** refresh occurs, all currently monitored events will be unregistered from before the configuration information is reread from the SDR. The SDR contains persistent information, so that a refresh results only in configuration changes that have been put into the SDR. If you have not deleted or modified a configuration record for a particular event, refreshing the daemon results in reregistering for the same event. To refresh **pmand** on the control workstation, issue **refresh -s**.

  ```
  refresh -s pman.system_partition_name
  ```

- To receive status on the **pmand** daemon, issue **lssrc -ls**. To check the status of **pmand** running on a node, enter:

  ```
  lssrc -ls pman
  ```

  To check the status of **pmand** running on the control workstation, enter:

  ```
  lssrc -ls pman.system_partition_name
  ```

  This command provides the following status information:

  – When **pmand** was started.

  – When **pmand** was last refreshed.

  – Whether tracing (debug mode) is on or off. When debug mode is on, all SRC requests and all events are logged to the **/var/adm/SPlogs/pman** directory.

  – Events for which registrations are as yet unacknowledged.

  – Events for which actions are currently being taken.

  – Events currently ready to be acted on by this daemon.

Creating Problem Management Subscriptions

The **pmandef** command is the mechanism provided for creating Problem Management subscriptions for the **pmand** daemon to Event Management services. The **pmandef** command provides for defining:

- Event Manager events to register for
- Actions to take when those events occur:
  - Run a command
  - Issue an SNMP trap
  - Write to the AIX Error Log and BSD syslog facilities

The **pmandef** command also provides for:

- Activating a Problem Management subscription
- Deactivating a Problem Management subscription
- Querying a Problem Management subscription
- Removing a Problem Management subscription

For more information on **pmandef**, refer to *PSSP: Command and Technical Reference*.

Running a Command

Use **pmandef** to specify a command to run when a specified event or rearm event occurs. For example:

```
pmandef -s Program_Monitor \
-e ‘IBM.PSSP.Prog.pcount:NodeNum=12;ProgName=mycmd;UserName=bob:X@0==0’\
-r “X@0>0” -c “echo program has stopped >/tmp/myevent.out” \
-C “echo program has restarted >/tmp/myrearm.out”
```

Running this example on node 5 causes the command **echo program has stopped >/tmp/myevent.out** to run on node 5 whenever the number of processes named **mycmd** and owned by user **bob** on node 12 becomes 0 (the event). When this number increases back to 1 (the rearm event), the command **echo program has restarted >/tmp/myrearm.out** runs on node 5.

You can specify if you want the command to run on a node other than the one from which the **pmandef** command was issued. For example:

```
pmandef -s Program_Monitor \
-e
‘IBM.PSSP.Prog.pcount:NodeNum=1-5,13;ProgName=mycmd;UserName=bob:X@0==0’\
-r “X@0>0” -c /usr/local/bin/start_recovery \
-C /usr/local/bin/stop_recovery -n 1-3,7
```

This example causes the commands to run on nodes 1, 2, 3 and 7, whenever **bob**'s program dies or gets restarted on any of nodes 1, 2, 3, 4, 5 or 13. If **bob**'s program dies on node 4, then the command **/usr/local/bin/start_recovery** runs on nodes 1, 2, 3 and 7.

Any number of commands can run simultaneously.

You can specify a timeout, in seconds, for each command. The minimum timeout that can be specified is 10 seconds. If the command has not exited before the specified timeout, the command is killed.

For information on command termination status, use the **lssrc -ls** command.

The Command Environment: The Problem Management subsystem makes all of the contents of an Event Management notification available in the command's environment when the command is run:

PMAN_HANDLE
The name that identifies this subscription to the Problem Management subsystem. This name was given as the argument of the **-s** flag to **pmandef**.

PMAN_PRINCIPAL
The name of the Kerberos V4 principal that owns this subscription, if one exists.

PMAN_DCEPRIN
The name of the DCE principal that owns this subscription, if one exists.

PMAN_RVNAME
The Event Management resource variable.

PMAN_IVECTOR
The Event Management resource identifier.

PMAN_PRED Either the Event Management expression or rearm expression, depending on whether this is an event or rearm event.

PMAN_TIME The time that the event was reported to the Problem Management subsystem.

PMAN_LOCATION
The node number of the node on which the event was generated, usually (but not always) the node on which the event occurred.

PMAN_RVTYPE
One of **long**, **float** or **sbs**, depending on whether the type of the resource variable value is a long integer, a floating point value or a Structured Byte String.

Note: If the PMAN_RVTYPE is either **long** or **float**, then the resource variable value is stored in PMAN_RVVALUE, and PMAN_RVVALUE is to be interpreted as type PMAN_RVTYPE.

If PMAN_RVTYPE is **sbs**, then the resource variable value is composed of one or more structure elements. There is no PMAN_RVVALUE environment variable. Instead there is a separate environment variable for each element, and the PMAN_RVCOUNT environment variable defines the number of elements. For example, if there are 3 structure elements within the Structured Byte String, the PMAN_RVCOUNT will be 3, and there will be 3 separate environment variables for the 3 structure elements: PMAN_RVFIELD0, PMAN_RVFIELD1 and PMAN_RVFIELD2. Each of these 3 environment variables contains a *name=value* pair, where *name* is the structure element name, and *value* is the structure element value.

For example, the following command:

```
pmandef -s example \
-e 'IBM.PSSP.Prog.pcount:NodeNum=9-11;ProgName=mycmd;UserName=root:X@0==0' \
-c "/usr/local/bin/recovery_cmd" -n 12
```

requests the **/usr/local/bin/recovery_cmd** command to run on node 12, when the number of processes named **mycmd** and owned by root on nodes 9, 10, or 11 becomes zero. If the **mycmd** program terminates on node 10, the command **/usr/local/bin/recovery_cmd** runs on node 12, and the following environment variables are included in its environment:

- PMAN_HANDLE (**example**)
- PMAN_PRINCIPAL (**root.admin@PPD.POK.IBM.COM**)
- PMAN_DCEPRIN (**/.../test_dcecell/cell_admin**)
- PMAN_RVNAME (**IBM.PSSP.Prog.pcount**)
- PMAN_IVECTOR (**ProgName=mycmd;UserName=root;NodeNum=10**)
- PMAN_PRED (**X@0==0**)
- PMAN_TIME (**Thu Aug 22 00:42:08 1996**)
- PMAN_LOCATION (**10**)
- PMAN_RVTYPE (**sbs**)
- PMAN_RVCOUNT (**3**)
- PMAN_RVFIELD0 (**CurPIDCount=0**)
- PMAN_RVFIELD1 (**PrevPIDCount=1**)
- PMAN_RVFIELD2 (**CurPIDList=**)

This information could be used by any command. Two utilities that report this information are provided as part of the Problem Management subsystem: **notify_event** and **log_event**. (These commands are provided to get you started; you may want to write more sophisticated commands.)

notify_event captures event information and mails it to the user running the command on the local node.

log_event captures event information and logs it to a wraparound file. The syntax for **log_event** is:

```
/usr/lpp/ssp/bin/log_event log_filename
```

log_event uses the AIX **alog** command to write to a wraparound file. The size of the wraparound file is limited to 64K. The **alog** command must be used to read the file. Refer to the AIX **alog** man page for more information on this command.

Issuing an SNMP Trap

Use the **pmandef** command to subscribe to an Event Management event and specify that an SNMP trap be issued for that event. For example:

```
pmandef -s Filesystem_Monitor \
-e 'IBM.PSSP.aixos.FS.%totused:NodeNum=10;VG=myvg;LV=mylv:X>95' \
-t 1234 -n 10
```

In this example, whenever the file system associated with the **mylv** logical volume and **myvg** volume group on node 10 becomes more that 95% full, an SNMP trap will be generated on node 10.

For complete information on how **pmand** can be configured to issue an SNMP trap when an event for which it is registered occurs, refer to Chapter 28, "Managing SP System Events in a Network Environment" on page 421.

Logging an Event

You can specify that **pmand** write event notification information, along with some optional specified text, to the AIX Error Log and BSD syslog facilities. For example:

```
pmandef -s Filesystem_Monitor \
-e 'IBM.PSSP.aixos.FS.%totused:NodeNum=11;VG=myvg;mylv:X>95' \
-l "filesystem is almost full" -h local
```

In this example, whenever the file system associated with the **mylv** logical volume and **myvg** volume group on node 11 becomes more than 95 % full, the text **filesystem is almost full** gets written to the AIX Error Log and BSD syslog facilities on node 11 (via the **-h local** option).

Obtaining Problem Management Access

The **pmandef** command is built upon the Sysctl facility, which uses the SP security services to provide authorized users, which may include both root and non-root users, with the ability to create, modify and delete Problem Management subscriptions. For further information about the Sysctl facility see Chapter 6, "Controlling Remote Execution by using Sysctl" on page 109.

How a user is authorized to access Problem Management depends on which SP trusted services authentication methods have been enabled:

- When DCE is the only authentication method enabled, access to Problem Management is protected by the DCE ACL for the **etc/sysctl.pman.acl** file. By default this DCE ACL contains an entry for the sysctl-pman DCE group. While you can modify the DCE ACL directly, IBM suggests that you authorize users to access Problem Management by adding their DCE principals to the **sysctl-pman** DCE group. For related information see "Managing Access by Group Membership" on page 49, "Managing Access using ACL Files" on page 51, and "Sysctl Files" on page 117.
- When Kerberos V4 or compatibility is the only authentication method enabled, access to Problem Management is protected by the **/etc/sysctl.pman.acl** file, which is a text file that gets processed by the Sysctl subsystem. You authorize users to access Problem Management by adding their Kerberos V4 principals to the **/etc/sysctl.pman.acl** file. For related information see "Sysctl Files" on page 117.
- When DCE and Kerberos V4 are both enabled as authentication methods, access to Problem Management is protected by both the DCE ACL and the **/etc/sysctl.pman.acl** text file described above. You authorize users to access Problem Management by adding their DCE principals to the **sysctl-pman** DCE group, by modifying the DCE ACL directly, or by adding their Kerberos V4 principals to the **/etc/sysctl.pman.acl** text file.
- When no authentication methods are enabled, access to Problem Management is protected by the /etc/sysctl.pman.acl text file. You cannot authorize individual users to access Problem Management. You can only authorize all unauthenticated users to access Problem Management. If you choose not to do this, then no users can access Problem Management. For related information see "Sysctl Files" on page 117.

Access to Problem Management is protected on a node by node basis. Each node contains a copy of the **/etc/sysctl.pman.acl** text file. When DCE authentication is enabled, there is a separate DCE ACL for each node. Therefore, it is possible for a user to be authorized to access Problem Management on some nodes but not on others. From a security standpoint, there is nothing to gain by authorizing a user to access Problem Management on some nodes but not on other nodes within a single SP system partition, because it is only necessary to have Problem Management access on a single node in order to define subscriptions that get processed on any nodes within the same SP system partition.

System administrators may consider granting Problem Management access to untrusted users. While an untrusted user may create a subscription that specifies that a command is to execute as root whenever the event occurs, the **pmand** daemon will not run such a command for an untrusted user. In fact, the **pmand** daemon will not perform any action that the end user is not otherwise allowed to do. However, by granting Problem Management access to a user, the system administrator authorizes the **pmand** daemon and other PSSP subsystems to consume system resources on behalf of this user. The risks involved range from wasting of system resources by careless users to denial-of-service attacks on the SP system by malicious users. While it may not be desirable to grant Problem Management access to all users, there may be some users who are not trusted enough to have the root password but are trusted enough to use Problem Management. For further information see “Authorizing Event Response Actions” on page 414.

The **pmandef** command requires the user to have Problem Management access on the local node to make the necessary changes to the SDR. If the user does not have Problem Management access on the local node, the command fails. The user should also have Problem Management access on the nodes that are affected by the subscription for the **pmand** daemons on those nodes to dynamically process the request. If the user does not have Problem Management access to any of these nodes, the **pmand** daemons on the unauthorized nodes will not process the request dynamically, but the request will eventually get processed the next time those **pmand** daemons get restarted or refreshed.

Understanding Subscription Ownership

When a new Problem Management subscription is created using the **pmandef -s** command, the user's current security identity is used to establish ownership of the subscription. Modifications to the subscription using the **pmandef** command with the -u, -d and -a flags are only allowed by a user who can be identified as the subscription owner.

How subscription ownership is established depends on which SP trusted services authentication methods have been enabled:

- When DCE is the only authentication method enabled, the user's DCE principal is used to establish subscription ownership. When a subscription gets created, the user's DCE principal gets stored into the SDR along with the rest of the subscription data. Modifications to the subscription using the -u, -d and -a flags are only allowed by a user who can be authenticated as this same DCE principal.
- When Kerberos V4 or compatibility is the only authentication method enabled, the user's Kerberos V4 principal is used to establish subscription ownership. When a subscription gets created, the user's Kerberos V4 principal gets stored into the SDR along with the rest of the subscription data. Modifications to the subscription using the -u, -d and -a flags are only allowed by a user who can be authenticated as this same Kerberos V4 principal.

- When DCE and compatibility are both enabled as authentication methods, either the user's DCE principal or Kerberos V4 principal is used to establish subscription ownership. When a subscription gets created, if the user is logged into both DCE and Kerberos V4, then both the DCE principal and Kerberos V4 principal get stored into the SDR along with the rest of the subscription data. If the user is not logged into both DCE and Kerberos V4, then whichever security identity is available, either the DCE principal or the Kerberos V4 principal, gets stored into the SDR. Modifications to the subscription using the -u, -d and -a flags are allowed only by a user who can be authenticated as the subscription owner using either security identity. If a subscription contains both a DCE principal and a Kerberos V4 principal, then a user who can be authenticated as either the DCE principal or the Kerberos V4 principal can modify the subscription. If a subscription does not contain a DCE principal, then only the Kerberos V4 principal is used to establish subscription ownership. Similarly, if a subscription does not contain a Kerberos V4 principal, then only the DCE principal is used to establish subscription ownership.
- When no authentication methods are enabled, subscription ownership is based on the combination of the user's AIX user name and source host name, the host name of the node from which the user issues the **pmandef** command. When a subscription gets created, the user's AIX user name (like root) and the host name of the node where the **pmandef** command is running (like node1.xyz.com) get stored into the SDR along with the rest of the subscription data. Modifications to the subscription using the -u, -d and -a flags are only allowed by the same AIX user running on the same node. This means that you can only run the **pmandef** command with the -u, -d and -a flags on the same node from which you issued the pmandef command with the -s flag to create the subscription.

Changing Subscription Ownership

If subscriptions are created while SP trusted services are enabled for one set of authentication methods, and later you reconfigure SP trusted services to use a different set of authentication methods, then it might not be possible to establish ownership of some subscriptions. For example, if subscriptions were created while DCE was the only authentication method enabled, and later Kerberos V4 becomes the only authentication method enabled, then the owners of the DCE-based subscriptions will not be able to modify their subscriptions since the subscriptions do not contain Kerberos V4 principals with which to establish ownership.

In these situations use the **pmanchown** command to change the ownership of the isolated subscriptions from a security identity that cannot be authenticated to something that can be authenticated. In the example above, the ownership of the DCE-based subscriptions can be changed from the user's DCE principal to the user's Kerberos V4 principal. For more information on the **pmanchown** command, see the book *PSSP: Command and Technical Reference*.

Authorizing Event Response Actions

After the **pmand** daemon receives notification that an event has occurred, and before it performs the action for that event, the **pmand** daemon checks to see whether the subscription owner is authorized to perform the requested action on the node where it is running. If the requested action is execution of a command, the subscription owner must have AIX Remote Commands access to the node as the target user. The target user is by default the same user who issued the **pmandef**

-s command to create the subscription. A different user can be specified to the **pmandef** command by using the -U flag.

The underlying principal is that the **pmand** daemon will execute a command in response to an event only if the subscription owner has the ability to execute the same command by other means. If the user can log in to the node as the target user and execute the command directly from the command line, or at least run the command as the target user by invoking the **rsh** command from a remote node, then no extra privileges can be gained from using Problem Management. The only thing the end user gains is the automation of responses to events within the SP system.

How event response authorization is done depends on the type of the subscription's ownership and which AIX remote command authentication methods have been enabled by the system administrator. In one case it also depends on which SP trusted services authentication methods have been enabled. The specific steps that **pmand** uses to determine whether the subscription owner is authorized to run a command as the requested target user on the local node are as follows:

- If the subscription contains a DCE principal, and if Kerberos V5 is enabled as an AIX remote command authentication method, then the subscription owner is authorized if the DCE principal's underlying Kerberos V5 principal has been listed in the target user's **$HOME/.k5login** file. If this step fails, authorization processing continues to the next step.
- If the subscription contains a Kerberos V4 principal, and if Kerberos V4 is enabled as an AIX remote command authentication method, then the subscription owner is authorized if the Kerberos V4 principal has been listed in the target user's **$HOME/.klogin** file. If this step fails, authorization processing continues to the next step.
- If no SP trusted services authentication methods are enabled, and if the subscription contains both a source AIX user name (the user who issued the **pmandef -s** command to create the subscription) and source host name (the node where the **pmandef -s** command was issued), and if standard UNIX is enabled as an AIX remote command authentication method, then the subscription owner is authorized if the source AIX user name and source host name combination have been listed in the target user's **$HOME/.rhosts** file. If this step fails, the subscription owner is not authorized, so the event response is not executed.

Note that standard UNIX authentication is not used when either DCE or Kerberos V4 has been enabled as an SP trusted services authentication method by the system administrator. This is necessary because, by enabling DCE or Kerberos V4 as an SP trusted services authentication method, the system administrator defines a security policy that requires all PSSP subsystems to use only strong forms of user authentication. Since standard UNIX authentication is a weak form of user authentication, it cannot be used when the PSSP security policy does not allow it.

When the action to be performed is an entry in the AIX error log and BSD syslog or the generation of an SNMP trap, all of the preceding rules apply, except the target user is always root, regardless of which target user is contained in the subscription. This restricts these actions to system administrators. Authorization checking for AIX error log and BSD syslog actions and SNMP trap actions are done separately from authorization checking for command execution actions. Therefore, if a subscription requests that a command executes for instance as `joeuser` and an SNMP trap gets generated in response to an event, the command authorization checking will use `joeuser` as the target user, while the SNMP trap authorization checking will use root as the target user.

When the action to be performed is execution of a command, the **pmand** daemon also checks to see whether the system administrator has imposed any AIX login restrictions for the target user on the local node. The **pmand** daemon enforces the same login restrictions as the AIX **rsh** service The login restrictions that are checked by both **pmand** and **rsh** include the following:

- Does the target user account exist?
- Has the target user's account been locked?
- Is the target user allowed to access the node at this time of day?
- Has the target user been specifically denied access to the **rsh** service by including the string `!RSH` in the **ttys** attribute for this user? (You can set the user's **ttys** attribute using the AIX **mkuser** or **chuser** commands.)

See the AIX security documentation for the entire list of user login restrictions which are enforced by the **rsh** service.

In most cases you can determine whether **pmand** will refuse to execute a user's command by answering the question "Can the subscription owner access the **rsh** service as the target user on the node where **pmand** is to execute the command?" Except for cases where **rsh** will allow authorization based on the target user's **$HOME/.rhosts** file and **pmand** will not, if the answer to this question is yes, then **pmand** will allow the user's command to execute. If the answer is no, then **pmand** will refuse to execute the command, and it will make note of this in the **pmand** daemon log file, which exists in the directory **/var/adm/SPlogs/pman**. Keep in mind that a target user's AIX login restrictions can vary from node to node, and the AIX remote command authentication methods can also vary from node to node, so the answer to this question can be yes for some nodes and no for other nodes within the same SP system.

Requesting Problem Management Subscription Information

Use the **pmanquery** command to query the SDR for a description of a Problem Management subscription. The **pmanquery** command outputs the details of the subscription information in raw format, which can then be used by other applications. The following example queries all subscriptions:

```
pmanquery -n all -k all -p all -U all -H all
```

For more information on **pmanquery**, refer to *PSSP: Command and Technical Reference*.

Monitoring Default Events

The Problem Management subsystem provides for a set of default events to be monitored in the **/usr/lpp/ssp/install/bin/pmandefaults** script. This script contains a series of **pmandef** commands that request an event notification to be mailed to root on the control workstation, when the specified event occurs. These are events that would interest many system administrators. Events are defined for all nodes in the current system partition, and all events are monitored from the control workstation. The list of events includes:

- The **/var** file system is more than 95 percent full.
- The **/tmp** file system is more than 90 percent full.
- An error log record of type **PERM** has been written to the AIX Error Log.
- The **inetd** daemon has terminated.
- The **sdrd** daemon has terminated (control workstation only).
- The **sysctld** daemon has terminated.
- The **hrd** daemon has terminated (control workstation only).
- The **fsd** daemon has terminated (nodes only).

This script is a suggested starting point for configuring the Problem Management subsystem on your SP system. You can choose to run the script as is, or you can make your own copy of the script and modify it to suit your needs, or you can choose not to run the script at all.

| The script takes no arguments. It can be executed once for each system partition.
| Specify the system partition by setting the SP_NAME environment variable.

Understanding the Problem Management Resource Monitor Daemon

The **pmanrmd** daemon is a resource monitor daemon that provides resource variables to Event Management services. When you install your SP system, a **pmanrmd** daemon is automatically configured on each node in a system partition. Additionally, there is a **pmanrmd** daemon running on the control workstation for each system partition in the SP system.

Controlling pmanrmd

The **pmanrmd** daemon is under the System Resource Controller (SRC). Only the following SRC commands are available for controlling the **pmanrmd** daemon:

- To start **pmanrmd** running, issue **startsrc -s** on a node.

  ```
  startsrc -s pmanrm
  ```

  To start **pmanrmd** running, issue **startsrc -s** on a control workstation.

  ```
  startsrc -s pmanrm.system_partition_name
  ```

- To stop**pmanrmd** running, issue **stopsrc -s** on a node.

  ```
  stopsrc -s pmanrm
  ```

  To stop **pmanrmd** running, issue **stopsrc -s** on a control workstation.

  ```
  stopsrc -s pmanrm.system_partition_name
  ```

No command is provided to refresh the **pmanrmd** daemon while it is running. To refresh the daemon, you must stop and start the daemon (using **stopsrc** and **startsrc**).

Creating Resource Monitors

The Problem Management subsystem provides sixteen resource variables, named **IBM.PSSP.pm.User_state1** through **IBM.PSSP.pm.User_state16**. You can associate values with the provided resource variables and configure **pmanrmd** to supply the values that you associate to Event Management services.

Associating Values with Problem Management Resource Variables

Two mechanisms are provided for associating values with the Problem Management resource variables:

1. The **pmanrminput** command
2. The **pmanrmd.conf** sample configuration file

The **/usr/lpp/ssp/bin/pmanrminput** command requires root authority to use. The command can be run from within scripts. It takes as arguments:

- The name of the SRC subsystem to which to communicate the request
- A string that consists of:
  - The name of one of the Problem Management supplied resource variables
  - A delimiter (+)
  - A string to provide as the value of the Problem Management supplied resource variable
  - Another delimiter (+)

For example, if you have a server application running on node 10 and you sometimes want to tell users on nodes 1-9 to stop using the server application, you could use the Problem Management subsystem to accomplish this. Create a Problem Management subscription on nodes 1-9 to run the **wall** command to inform the users about the state of the server application:

```
pmandef -s ready_or_not \
-e ‘IBM.PSSP.pm.User_state3:NodeNum=10:X@0==“READY”’ \
-r ‘X@0!=“READY”’ \
-c “wall Node 10 is ready” -C “wall Stop using node 10” -n 1-9
```

When the server application is ready for users, it uses the **pmanrminput** command to communicate its state to the Problem Management subsystem:

```
pmanrminput -s pman -a “IBM.PSSP.pm.User_state3+READY+”
```

The Problem Management subsystem passes the string **READY** to Event Management as the value of the resource variable **IBM.PSSP.pm.User_state3**, and that value satisfies the event definition, so the command **wall Node 10 is ready** runs on nodes 1-9. When the server application has a problem, it can use **pmanrminput** to communicate its state change:

```
pmanrminput -s pman -a “IBM.PSSP.pm.User_state3+NOT READY+”
```

The resource value **NOT READY** satisfies the rearm event definition, so the command **wall Stop using node 10** runs on nodes 1-9.

Another way to associate a value with one of the Problem Management resource variables is to provide the name of the resource variable and a command in a configuration file, based on the **pmanrmd.conf** sample file (for more information on the **pmanrmd.conf** sample file refer to “Configuring pmanrmd to Provide Resource

Variables" on page 419). The standard output of the command will be provided to Event Management services as the value for the specified Problem Management resource variable.

Configuring pmanrmd to Provide Resource Variables

In the example in "Associating Values with Problem Management Resource Variables" on page 418, the resource, an application server, was able to communicate its state change directly to the Problem Management subsystem. However, this is not always possible. For example, if you want to run a command whenever the contents of the **/etc** directory on nodes 1-5 change, the **/etc** directory is the resource, and a directory is not capable of stating when it has changed. In this case, the Problem Management subsystem needs to be configured to periodically send the name and time stamp of the last changed file in the **/etc** directory as the resource variable value to Event Management. This can be accomplished by defining a resource monitor command to the Problem Management subsystem.

A sample **pmanrmd.conf** file is provided. Copy, rename, and edit this file to specify:

- The node(s) on which **pmanrmd** is to be configured
- The name of the Problem Management resource variable to provide via **pmanrmd**
- A sampling interval (in seconds) for each resource variable
- The command to run to produce the standard output that will be provided as the value for the Problem Management resource variable

For example:

```
TargetType=NODE_RANGE
Target=1-5
Rvar=IBM.PSSP.pm.User_state2
SampInt=600
Command="/bin/ls -tl /etc | /bin/head -2 | /bin/grep -v total"
```

In this example, the **pmanrmd** daemon will run the command **/bin/ls -tl /etc | /bin/head -2 | /bin/grep -v total** every ten minutes, and it will send the output of that command as the value of the resource variable **IBM.PSSP.pm.User_state2** to Event Management. The output of this command is the name of the last file to be changed and its time stamp. You could then subscribe to changes in the **/etc** directory resource with the following command:

```
pmandef -s etc_file_changed \
-e 'IBM.PSSP.pm.User_state2:NodeNum=1-5:X@0!=X@P0' \
-c "echo somebody changed a file in /etc >/tmp/etc_change_log"
```

Whenever the most recent output of the **/bin/ls -tl /etc | /bin/head -2 | /bin/grep -v total** command is different from the previous output, the event definition will be satisfied, and the **"echo somebody changed a file in /etc >/tmp/etc_change_log"** command will get executed.

Loading pmanrmd Configuration Information into the SDR

pmanrmdloadSDR reads the configuration file and loads the information in the stanzas into the SDR. **pmanrmdloadSDR** runs on the control workstation.

The syntax for **pmanrmdloadSDR** is :

```
pmanrmdloadSDR configuration_file
```

After you load the configuration information into the SDR, refresh the affected **pmanrmd** daemons.

Chapter 28. Managing SP System Events in a Network Environment

IBM Parallel System Support Programs for AIX includes a Problem Management subsystem (refer to Chapter 27, “Using the Problem Management Subsystem” on page 405) that provides access to Event Management function without the necessity of writing C programs that use the Event Management APIs. The Problem Management subsystem gives you the ability to subscribe to Event Management events and to specify actions for those events. Issuing an SNMP trap in response to an event (which can come either from Event Management or the AIX Error Log) is one of the actions you can specify.

The ability to issue an SNMP trap in response to an event allows you to report problem events occurring in your SP system to a network manager existing on a remote node (a network manager application is not supplied with the SP). The Problem Management subsystem provides an SP SNMP proxy agent, **sp_configd**, (sometimes referred to as a *subagent daemon*) that runs on the control workstation and every SP processor node. The SP proxy agent provides the following functions:

1. A Management Information Base (MIB)
2. SNMP **GET** and **GET NEXT** command support that allows data in the MIB to be accessed by a network manager application
3. Creation and transmittal of SNMP traps to an installation-defined network manager application when the following events occur on the node on which the SP proxy agent is running:
   - A *cold start* trap is issued when the agent is activated
   - An enterprise-specific trap is issued when an entry with an “alert=true” attribute is written in the AIX Error Log
   - An enterprise-specific trap is issued when an user-specified event is detected within Event Management services

This chapter provides overview and task information for making the SP part of a network management system. In such a system, for example, the SP presents error event information, in the form of SNMP traps, to a network management application, such as NetView for AIX, which displays and logs the trap, and may notify a problem management application, such as Trouble Ticket for AIX, of problem events occurring on the SP.

In order for the SP to be part of such a network management system, network managers must be notified when selected AIX Error Log entries are written and Event Management events occur. SP-specific configuration data is provided so that management applications can determine which nodes compose the SP system. You decide what Error Log and Event Management events will trigger manager notification.

This chapter first discusses general concepts related to Network Management and then discusses information specific to enabling the reporting of SP system events in a network environment. For further discussion of Simple Network Management Protocol and the Management Information Base, refer to *IBM AIX Communications Programming Concepts*.

Understanding Network Management

The Simple Network Management Protocol (SNMP) describes how management data is packaged and transported through the network in order for SNMP agents and SNMP network managers to communicate. The Management Information Base (MIB) defines the structure of the data being transported.

Understanding SNMP

SNMP uses a client/server approach to management, defining two roles: Manager (client) and Agent (server).

The Manager (NetView for AIX is an example) oversees the overall network activity. Critical events in the form of SNMP traps are sent to this Manager to alert network operators of problems in the network. The Manager also acts as the central point for storing and displaying statistics maintained by the Agent (server). These statistics are maintained by the Agent in the form of MIB variables.

The Agent is responsible for reporting on and maintaining the data pertaining to a managed resource, such as a device or, in the case of the SP Agent, a set of configuration information identifying the nodes composing the SP system and tables of resource attributes within the SP which can be monitored. Agents can run on several different types of managed nodes.

Understanding the MIB

Every Agent supports a Management Information Base (MIB), a set of variables that represent the physical and logical resources of the managed systems or Agent. The MIB is not a database, in the sense of a monolithic collection of data, but rather it represents dynamic information. The values of the variables are maintained by different system functions such as the kernel, device drivers, or subsystems. The Agent obtains the variable values from these system functions.

The Manager can read variable values via these SNMP requests:

GET	Requests the SNMP Agent to retrieve the value of the specified variable and return it to the requester (the Manager).
GET NEXT	Requests the SNMP Agent to retrieve the value of the next variable, after the one specified in the request, and return it to the Manager. This is especially useful for retrieving tabular information, and multiple variables can be requested in it.

To summarize, the SNMP Manager determines the status of Agents by using the GET request to poll the Agents on a regular basis. However, if an Agent discovers an exceptional event, it will alert the Manager immediately, without waiting for a GET request, by sending a trap. The trap does not necessarily describe the problem in any detail; it simply informs the Manager that there is a change of state within the resources managed by the Agent, and the Manager may poll the Agent via an SNMP GET or GET NEXT request to determine more detail about the problem.

Enabling Network Management for the SP System

For an SP to be part of a network management system, network managers must be notified of the AIX Error Log or Event Management events that you would like to centrally manage. A section of the SP proxy agent MIB (contained in the **/usr/lpp/ssp/config/snmp_proxy/ibmSPMIB.my** file) contains SP-specific SNMP configuration data, enabling Managers to view the SP as a system composed of processor nodes and a control workstation. In other words, there must be a way to create SNMP traps for SP error or problem events and there must be a MIB that contains configuration information specific to the SP system.

SNMP Traps for the SP from AIX Error Log Events

The **snmp_trap_gen** error notification method notifies the **sp_configd** daemon (or SP proxy agent) to create SNMP traps when selected types of errors are recorded in the AIX Error Log. (Note that the **trapgend** method from NetView for AIX also creates SNMP traps from AIX Error Log events. **trapgend** formats such events to be specifically compatible with SNA alerts. Only one of these methods should be used to avoid duplicate traps being generated for a single error.) The method and daemon run on each processor node and control workstation composing the SP system. In order for a trap to be created, using the **snmp_trap_gen** method, error log entries on each node and control workstation must contain an “alert=true” attribute. The following steps describe the flow of events for creating an SNMP trap for an AIX Error Log event:

1. An application or subsystem writes to the AIX Error Log facility.
2. If the Error Log entry contains an “alert=true” attribute, the **snmp_trap_gen** error notification method runs.
3. The **snmp_trap_gen** method uses the sequence number from the Error Log entry as input to the **errpt -a** command to obtain full information about the event.
4. **snmp_trap_gen** places the event information in a FIFO file, **/var/tmp/errlog_entry**
5. **sp_configd** reads the FIFO file, parses the information into objects within the **ibmSPErrlogVars** group of the **ibmSP** MIB and creates a trap from the objects whose instantiations contain non-null values.
6. **sp_configd** sends the trap to the AIX agent, **snmpd**, which in turn sends the trap to network managers specified in the **/etc/snmpd.conf** file existing on the node.

The following information is provided in SNMP traps from AIX Error Log events generated using the **snmp_trap_gen** method and the **sp_configd** daemon.

- The **enterprise** field contains the OID (object identifier) of the **sp_configd** subagent (this is the OID assigned to the **ibmSP** MIB)
- The **specific-trap** field contains the error ID from the Error Log entry (this is the convention expected by NetView for AIX when configuring events)
- When the corresponding information exists in the Error Log entry, the **variable bindings** field contains the following object values paired with their OIDs:
  - Error label
  - Error ID
  - Error log entry time stamp

  - Unique sequence number
  - Machine ID parameter
  - Node ID parameter
  - Error class
  - Error type
  - Resource name
  - Resource class
  - Resource type
  - Identifies the location code of a device
  - Vital product data
  - Error description
  - Probable causes
  - User causes
  - User actions
  - Install causes
  - Install actions
  - Failure causes
  - Failure actions
  - Detail data

Other fields in the trap are as specified by SNMP protocol.

Note: the values for objects with a syntax of 'DisplayString' are always in the form of English ASCII character strings which are not subject to translation.

Designating AIX Error Log Entries as Alertable

In order for **sp_configd** to pass any entries in the system error log as traps to the **snmpd** daemon for transmission to Network Managers, the Error Record Templates for the entries must have the specific “alert” field set to the value **true**. (Make sure you are authenticated as the root user.) This may be accomplished as follows:

1. On the system in which the **sp_configd** daemon is running, use the **errpt -t** command to list the templates for entries in the AIX Error Log.
2. Select the IDs of the entries for which you wish to have traps issued when they occur.
3. Create a file containing the following two lines for each entry to be designated alertable:
   ```
   = ID:
   alert = true
   ```
4. From the command line, enter:
   ```
   errupdate file
   ```
5. To verify that the alert status has been changed to “true” (or 1), enter:
   ```
   errpt -tF alert=1 | grep ID
   ```
   listing the error template. You should see the specified ID listed.

SNMP Traps for the SP from Event Management Events

The following steps describe the flow of events for creating an SNMP trap for an Event Management event:

Designating that an SNMP Trap is Issued for an Event Management Event

1. Use the **pmandef** command to subscribe to an Event Management event and specify that an SNMP trap be issued for that event. For example:

   ```
   pmandef -s Filesystem_Monitor /
   -e'IBM.PSSP.aixos.FS%totused:NodeNum=10;VG=myvg;LV=mylv:X>95' /
   -t 1234 -n 0
   ```

   (In this example, whenever the file system associated with the **mylv** logical volume and **myvg** volume group on node 10 becomes more that 95% full, an SNMP trap will be generated on the control workstation.)

2. **pmand** (the Problem Management Event Management client daemon) subscribes to the event as specified in the **pmandef** command. The event must occur on the local node on which **pmand** is running.

3. **pmand** writes the contents of the Event Manager subsystem-supplied event response and the user-specified event configuration information into a FIFO file

4. **sp_configd** reads the data and creates an SNMP trap from it

5. **sp_configd** sends the trap to the SNMP managers specified in the **/etc/snmpd.conf** file on the node.

6. You specify a particular trap ID in the configuration information for an Event Manager event.

The following information is provided in SNMP traps from Event Management events generated by the **sp_configd** daemon.

The Contents of SNMP Traps Containing Event Management Events

- The **enterprise** field contains the OID of the **ibmSP** MIB
- The **specific-trap** field contains the trap ID field from the **pmand** configuration for this event. This allows configuration of NetView for AIX actions based on the type of event (which is done based on the specific trap ID)
- The **variable bindings** field contains the following object values paired with their OIDs:
  - The event ID
  - Event flags
  - A time stamp indicating the time the Event Manager generated the event
  - The number of the node and the system partition address where the event occurred
  - The resource variable name
  - MIB table and instance information allowing further information about the variable involved with the event to be obtained from the **ibmSP** MIB.
  - The value of the resource variable that triggered the event
  - The predicate for which the event was triggered

Other fields in the trap are as specified by SNMP protocol.

The MIB for the SP

The **ibmSP** MIB is provided to define SP-specific information. The **ibmSP** MIB consists of an **ibmSPConfig** group, the **ibmSPErrlogVars** group, and the **ibmSPEMVariables** group. The **ibmSP** MIB is instantiated on each SP processor node and the control workstation.

The **ibmSP** MIB is defined in the source file **ibmSPMIB.my** in the **/usr/lpp/ssp/config/snmp_proxy** directory. For a sample of the **ibmSP** MIB file, see “ibmSPMIB.my” on page 510.

The **ibmSPConfig** group defines objects containing SP system configuration information. The group consists of objects containing the following information:

- The node number of the node on which the queried subagent is running
- The IP address of the system partition in which the queried node resides
- The host name of the primary control workstation.
- The operational state of the primary control workstation (up or down)
- The host name of the backup control workstation (will be **NULL** if none exists)
- The operational state of the backup control workstation (up or down)
- The version number of the IBM Parallel System Support Programs for AIX running on the control workstation
- A table of SPNodeEntrys. Each row in the table is indexed by the IP address of a system partition combined with a node number. Each row contains the following information about a node:
  - The IP address of the system partition in which it resides
  - The node number
  - The number of the frame containing the node
  - The lowest slot number in the frame containing the node
  - The number of slots in the frame occupied by the node
  - The reliable host name assigned to the node (this is the host name associated with the SP Ethernet)
  - The initial host name assigned to the node (this is the host name assigned to the node during the customization based on data obtained from the SP Perspectives GUI)
  - The name of the system partition in which the node resides
  - The version number of the IBM Parallel System Support Programs for AIX running on the node

The **ibmSPConfig** group, when instantiated on the control workstation, will identify the default system partition IP address as the IP address of the system partition containing the reporting node and **0** as the node number of the reporting node.

The **ibmSPErrlogVars** group is instantiated on each SP processor node and the control workstation. The group consists of a sequence of objects containing information about the latest Error Log write that caused an SNMP trap to be issued on the reporting node.

The **ibmSPEMVariables** group is instantiated on each SP processor node and the control workstation. The group consists of a sequence of objects containing information about the last Event Management event that caused an SNMP trap to be issued on the reporting node and tables of objects representing Event Management variables. The group contains up to three tables:

- A table of objects (**ibmSPEMNodeDepVarsTable**) allowing access to the definitions of node-dependent resource variables (those defined with an Event Manager *Locator* attribute). This table contains object instantiations for only those variables which have a Locator value equalling the node number of the node on which the SP proxy agent is running.
- A table of objects (**ibmSPEMNodeIndepVarsTable**) allowing access to the definitions of node-independent resource variables (those defined without an Event Manager *Locator* attribute)
- A table of objects (**ibmSPEMVarValuesTable**) allowing access to the current values assigned to Event Management resource variables

The following information is provided through object instantiations for each of the Event Management resource variables in the **ibmSPEMNodeDepVarsTable** and **ibmSPEMNodeIndepVarsTable** tables:

- Strings containing the following Event Management variable information:
  - Name of the resource variable
  - Resource variable description
  - Variable type (counter, quantity, or state)
  - Data type (long, float, structured byte string)
  - Structure byte string format (only for a structured byte string data type)
  - Initial variable value
  - An index into the **ibmSPEMVarValuesTable**, which, when used in combination with an instantiation vector, provides access to an entry containing the current value of a variable instance
  - Variable's resource class
  - Instantiation vector definition
  - Description of each element in the instantiation vector
  - Name used to read and write the variable in the PTX shared (may be **NULL**) memory
  - Default predicate for event notification (may be **NULL**)
  - A description of the event
  - Locator value specified for the variable
  - Resource order group

The **ibmSPEMVarValuesTable** provides object instantiations for the current values of variables from both the **ibmSPEMNodeDepVarsTable** and the **ibmSPEMNodeIndepVarsTable** tables.

The portion of the **ibmSPEMVariables** group instantiated by the **sp_configd** subagent depends on the type of SP node the subagent is running on. The **ibmSPEMNodeDepVarsTable** and **ibmSPEMVarValuesTable** tables are instantiated on all the processor nodes and the control workstation. The **ibmSPEMNodeIndepVarsTable** table is instantiated on only the control workstation.

Viewing the ibmSP MIB

The AIX **snmpinfo** command may be used in place of a manager client, such as NetView for AIX, to view the contents of the **ibmSP** MIB. Use of this command requires **root** authentication. The following are examples of using **snmpinfo**:

1. To dump the contents of the **ibmSP** MIB located on the host *host_name* in verbose mode, enter the command:

   ```
   snmpinfo -m dump -v -h host_name ibmSP
   ```

2. To dump the contents of the **ibmSPConfig** group, enter the command:

   ```
   snmpinfo -m dump -v -h host_name ibmSPconfig
   ```

3. To get values for the MIB variable **SPhostnodenumber.0** located on the local host, enter:

   ```
   snmpinfo -m get ibmSPhostnodenumber.0
   ```

4. To get the value for the MIB variable following the **ibmSPhostnodenumber** variable, enter:

   ```
   snmpinfo -m next ibmSPhostnodenumber.0
   ```

Disabling Network Management for the SP System

If the SP is not part of a network management system, you can delete the **sp_configd** subsystem by issuing the following command on each SP processor node and on the SP control workstation:

```
/usr/lpp/ssp/bin/sp_configdctrl -c
```

This will delete the **sp_configd** subsystem from the SRC, and remove **sp_configd** entries from the following files:

- **/etc/inittab**
- **/etc/snmpd.conf**
- **/etc/snmpd.peers**

And it will remove the **ibmSP** MIB definitions appended to:

- **/etc/mib.defs**

Configuring the SP Proxy Agent

The SP proxy agents (**sp_configd**) residing on each managed SP node and control workstation are configured to be started automatically whenever AIX is started. The configuration changes necessary to accomplish this are performed during installation on the nodes and the control workstation.

If you have a management station that "listens" for traps, place the information for the trap destination in the **/etc/snmpd.conf** file on each SP node and control workstation. Instructions for doing this are in the **/etc/snmpd.conf** file. The following steps are performed automatically by the **syspar_ctrl** script on each node and the control workstation when the PSSP software is installed:

1. These steps presume that the standard AIX Agent is already configured to be managed by the desired Managers. If this is not the case, see the information contained in the **/etc/snmpd.conf** file for required updates to the file. This update must be made on every SP node and the control workstation.

2. The **/etc/snmpd.conf** file is modified to add the SP subagent (**sp_configd**) to the set of SMUX peers with a “smux” record
3. The SP MIB file **/usr/lpp/ssp/config/snmp_proxy/ibmSPMIB.defs** is appended to the **/etc/mibs.def** file. The **/usr/lpp/ssp/config/snmp_proxy/ibmSPMIB.defs** file is compiled from **ibmSPMIB.my**
4. Information for the new **sp_configd** subagent is added to the **/etc/snmpd.peers** file. The information is the OID of the Agent and the community name (password).
5. The **snmpd** daemon is refreshed.
6. The daemon is started under SRC control.
   a. An src_entry for **sp_configd** is added to the AIX Object Data Manager (ODM) so that the daemon can be controlled using the **startsrc** command. The **src_entry** invokes the **startsrc** command with the following parameters:

      ```
      -s sp_configd -a “-t 600” -p /usr/lpp/ssp/bin/spconfigd
      -u 0 -i /dev/null -o /dev/null -e /dev/null -S -n 15 -F 15
      ```

   b. An entry is added to the AIX **inittab** file to start the daemon by issuing the command:

      ```
      /usr/bin/startsrc -s sp_configd
      ```

   c. The **sp_configd** daemon supports a **-t** switch that determines the amount of time (in seconds) for which data is to be cached by the daemon and re-fetched when a new request for the data is received. The default value is 60 seconds. The default can be changed in the src_entry or the **startsrc** command contained in the **inittab** file, or by entering **startsrc** at the command line.
   d. The daemon can be stopped by issuing:

      ```
      /usr/bin/stopsrc -s sp_configd
      ```

Configuring NetView for AIX for the SP System

If you are using NetView for AIX as the network manager for your SP system, you must configure it to recognize SP trap and configuration information.

Configuring the SP MIB to be Used by NetView for AIX

1. Copy the file **/usr/lpp/ssp/config/snmp_proxy/ibmSPMIB.my** from an SP node into **/usr/OV/snmp_mibs** as **ibmSP.mib** on the node running NetView for AIX.
2. If you have dependent nodes attached to your SP system, copy the file **/usr/lpp/ssp/config/spmgrd/ibmSPDepNode.my** from the control workstation into **/usr/OV/snmp_mibs** as **ibmSPDepNode.mib** on the node running NetView for AIX.
3. Load the appropriate MIBs using the NetView for AIX menu option **Load/Unload MIBs**.

Configuring SP Events to be Used by NetView for AIX

Traps generated containing events from SP nodes and the control workstation are displayed automatically at the NetView for AIX **Control Desk** if the node on which the event originated is a managed node. If the node is not managed, the event is recorded in the event history file and is displayed only when you query the event history file. The traps contain object values indicating:

- The trap ID
- The variable name
- The event predicate definition that caused the event
- The value of the variable at the time the event was generated
- Information necessary to use the NetView for AIX browse facility to query the node for the current value of the variable or for more information about the characteristics of the variable and its value.

You may tailor the information in the traps by using the **Trap Customization** selection under the **Event/Configuration** AIX menu option.

Chapter 29. Managing Error Logs

The IBM RS/6000 SP (SP) use both the BSD syslog and AIX Error Logging facilities, as well as a number of function-specific log files to record error events on each node. Refer to the *PSSP: Diagnosis Guide* for an overview of error logging and a description of SP specific log files.

This chapter describes error log management functions provided in the **ssp.sysman** install option of the IBM Parallel System Support Programs for AIX (PSSP). Error log management consists of:

- SMIT panel interfaces
- A set of external commands
  - **splm** for general log viewing, archiving, and service collection
  - **psyslrpt** for generating reports of BSD syslog log files
  - **psyslclr** for trimming BSD syslog log files
  - **penotify** for creating, removing, or displaying Error Notification Objects
- Sysctl-based server functions

This chapter discusses how to perform the following tasks:

- Manage the AIX Error Log facility
- Manage the BSD syslog facility
- Archive error logs
- View error logs
- Collect system data for IBM Service

To access the primary SMIT menu for managing error logs:

TYPE **smit**

- The System Management menu appears.

SELECT RS/6000 SP System Management

- The RS/6000 SP System Management menu appears.

SELECT RS/6000 SP Log Management

- The RS/6000 SP Log Management menu appears.

The fastpath invocation for the Log Management menu is:

```
smit splogmgt
```

| ## Installing and Configuring Error Log Management

| Log management functions are built upon the Sysctl facility, which uses the SP
| security services. Configuring Log Management and how users obtain authorization
| is different when using DCE and when using Kerberos V4.

Configuring Log Management with DCE Authentication

When using DCE authentication, a user of log management can obtain authorization by using the **dce_login** command with a DCE principal that is a member of the **sysctl-logmgt** group. The user can also be authorized by some other entry added to the DCE ACL for the **/etc/logmgt.acl** file by an SP security administrator who is a member of the **spsec-admin** group. For related information see “Managing Access by Group Membership” on page 49, “Managing Access using ACL Files” on page 51, and “Sysctl Files” on page 117.

Configuring Log Management with Kerberos V4 Authentication

When using Kerberos V4 authentication, the user needs to issue the **k4init** command to be identified to the SP authentication services in order to generate parallel AIX Error Log and BSD syslog reports and view any logs. All other log management commands additionally require that the user be defined as a principal in the **/etc/logmgt.acl** file. All users defined in the file **/etc/logmgt.acl** must also be placed in the authentication (PSSP Kerberos V4 or AFS) database as a principal. (Refer to “Adding Principals and Assigning Initial Passwords” on page 38 for more information.) Note that the majority of log management represents administrative tasks normally requiring root authority and that a user defined in the **logmgt.acl** file will execute commands as the root user.

The following is an example of an **/etc/logmgt.acl** file:

```
#acl#
# This sample acl file for log management commands contains
# a commented line for a principal
#_PRINCIPAL root.admin@HPSSL.KGN.IBM.COM
# for trimming SPdaemon.log by cleanup.logs.ws
_PRINCIPAL rcmd.k7s
```

For related information see “Managing Access by Group Membership” on page 49, “Managing Access using ACL Files” on page 51, and “Sysctl Files” on page 117.

Configuring Sysctl for Log Management

The log management server functions executed by Sysctl are located in **/usr/lpp/ssp/sysctl/bin/logmgt.cmds**. During system installation, an include statement for this file is added to the default Sysctl configuration file **/etc/sysctl.conf**. If you use an alternate Sysctl configuration file, you must update the file with a statement to include the **logmgt.cmds** file. In addition, you must restart the **sysctld** daemon to pick up this change. See Chapter 6, “Controlling Remote Execution by using Sysctl” on page 109 for a description of the Sysctl function, ACL and AUTH callback authorizations, using an alternate Sysctl configuration file, and other Sysctl configuration information.

Managing the AIX Error Log Facility

For detailed information on the AIX Error Log facility, refer to:

- *IBM RS/6000 Problem Solving Guide*
- *IBM General Concepts and Procedures for RS/6000*

You can perform the following tasks using either SMIT menus or commands:

- Generate AIX Error Log reports

- Trim AIX Error Log reports
- Configure AIX Error Logs
- Manage error notification objects
- Manage error templates

When you execute commands related to AIX Error Log management you can specify whether the command should be executed on all nodes in the current system partition or you can specify node names or the name of a file containing a list of node names. The default is the local node.

From SMIT

To access the AIX Error Log SMIT menu, enter:

```
smit sperrlog
```

Generating AIX Error Log Reports

You can generate reports on entries in the AIX Error Log on a number of nodes. The report can be displayed or written to a file on the local node.

From SMIT

The fastpath invocation for the Generate an Error Report menu is:

```
smit perrpt
```

Trimming AIX Error Logs

You can trim records from error logs on a set of nodes.

From SMIT

The fastpath invocation for the Clean the Error Log menu is:

```
smit perrclear
```

Configuring the AIX Error Log

You can display the configuration parameters of the AIX Error Log to the local node.

From SMIT

The fastpath invocation for the Show Characteristics of the Error Log menu is:

```
smit perrdemon_shw
```

You can alter one or more of the configuration parameters for the AIX Error Log on a set of nodes. Because of the additional entries generated by SP system software, you should set the AIX Error Log file size to be a minimum of 4MB.

From SMIT

The fastpath invocation for the Change Characteristics of the Error Log menu is:

```
smit perrdemon_chg
```

Managing Error Notification Objects

Error Notification Objects are ODM objects held in the class errnotify that are used by the AIX Error Notification Facility to invoke methods upon occurrence of an error event. Fields in the errnotify class match to fields in an Error Template for selection. If an error is logged matching the selection criteria defined in a notification object, the method associated with that object is invoked. For more information on using the AIX Error Notification Facility, refer to *IBM General Concepts and Procedures for RS/6000*.

You can add, remove, and show notification objects in parallel on the SP system.

From SMIT

- The fastpath invocation for the Add a Notification Object menu is:

  ```
  smit padd_en
  ```

- The fastpath invocation for the Remove a Notification Object menu is:

  ```
  smit prem_en
  ```

- The fastpath invocation for the Show a Notification Object menu is:

  ```
  smit pshw_en
  ```

From the Command Line

To add, remove, or show error notification objects in parallel on the SP system, enter:

```
penotify -f show
```

For complete details on the command, refer to the *PSSP: Command and Technical Reference*.

Following is a description of the actions taken by the notification method EN_pend located under the **/spdata/sys1/err_methods** directory. This method can be installed and used to invoke pre- and post- action scripts and mail a report of the logged error. This script provides a suggested structure for notification methods and can be reused with different pre- or post- action scripts as described in the sections.

EN_pend Method Flow

1. EN_pend looks under the directory it resides in for a file with the same name and a **.envs** suffix. If found, it sources the file to pick up environment variables EN_RUNDEFAULT and EN_MAILLOC. An **EN_pend.envs** script is installed under the same directory.
2. **EN_pend.envs** sets the EN_RUNDEFAULT environment variable. It also sets the EN_MAILLOC to root at the control workstation, if possible, or to root at the local node.
3. **EN_pend** checks for a pre-action script under the same directory and name with a **.pre** suffix and executes it if found.
4. **EN_pend** mails an expanded report of the error using the sequence of the error passed by the notification facility to the EN_MAILLOC, if EN_RUNDEFAULT and EN_MAILLOC variables are set.
5. **EN_pend** checks for a post-action script under the same directory and name with a **.post** suffix and executes it if found.

Installing a Notification Object

To add the **EN_pend** method to all nodes in the current partition to send a report whenever an error of type PEND (loss of availability of a device is imminent) occurs, enter:

```
penotify -a -n “PEND_err” -P -t “PEND” -f add \
-m ‘/spdata/sys1/err_methods/EN_pend $1’

penotify -a -n “pend_err” -P -t “pend” -f add \
-m ‘/spdata/sys1/err_methods/EN_pend $1’

penotify -a -n “Pend_err” -P -t “Pend” -f add \
-m ‘/spdata/sys1/err_methods/EN_pend $1’
```

The **-P** flag will cause the object to persist after the system is restarted. Three objects are added with variations on PEND because upper case is not always adhered to by all AIX LPPs and vendor functions. The **$1** argument causes the Error Notification Facility to pass the error sequence number to the notify method.

The **EN_pend** and **EN_pend.envs** scripts can be used to invoke different pre- and post-action scripts for different error events by creating links to them. **EN_pend** looks for **.envs**, **.pre** and **.post** scripts under the directory it is called from, and by the same basename. For example, to use **EN_pend** for reporting hdisk0 errors on nodes h0, h1, h2 and h3 and perform pre- and post- action:

1. Create .pre and .post action scripts on one of the nodes, for example, EN_hdisk0.pre, EN_hdisk0.post under the **/spdata/sys1/err_methods** directory on node h0.
2. Copy the pre- and post- scripts to nodes h1, h2 and h3 using **pcp**:

   ```
   pcp -w h1,h2,h3 EN_hdisk0.pre /spdata/sys1/err_methods/
   pcp -w h1,h2,h3 EN_hdisk0.post /spdata/sys1/err_methods/
   ```

3. Create links to the **EN_pend** and **EN_pend.envs** scripts:

   ```
   dsh -w h0,h1,h2,h3 ln -s /spdata/sys1/err_methods/EN_pend \
   /spdata/sys1/err_methods/EN_hdisk0

   dsh -w h0,h1,h2,h3 ln -s /spdata/sys1/err_methods/EN_pend.envs \
   /spdata/sys1/err_methods/EN_hdisk0.envs
   ```

4. Add the notification object:

   ```
   penotify -w h0,h1,h2,h3 -f add -P -n “hdisk0_err” \
   -m '/spdata/sys1/err_methods/EN_hdisk0 $1' -N “hdisk0”
   ```

To display the notification object created, enter:

```
penotify -w h0,h1,h2,h3 -f show -n “hdisk0_err”
```

To remove this notification object, enter:

```
penotify -w h0,h1,h2,h3 -f remove -n “hdisk0_err”
```

Note: Notification methods need to be accessible to each node that the notify object is added to. We suggest that the notification scripts be kept local on each node in case of network failure. File collections should be used to maintain updates to notification methods.

Managing Error Templates

You can create a new error template in the Error Template repository for logging errors.

From SMIT

The fastpath invocation for the Add an Error Template menu is:

```
smit padd_et
```

You can remove a template from the Error Template Repository.

From SMIT

The fastpath invocation for the Remove an Error Template menu is:

```
smit prem_et
```

You can display entries from the Error Template Repository to the local host.

From SMIT

The fastpath invocation for the Show an Error Template menu is:

```
smit pshw_et
```

Managing the BSD syslog Facility

SP error logging utilizes the BSD syslog facility for recording error events.

From SMIT

To access the Syslog SMIT menu, enter:

```
smit spsyslog
```

Generating Reports on BSD syslog Log Files

The **syslogd** daemon, which logs the errors, is configured with a file designating filters for the incoming messages to determine their destination. The default configuration file is **/etc/syslog.conf**. BSD syslog errors are classified by the facility that is issuing the error, and by the error's priority value. Refer to **syslogd** in the *IBM AIX Commands Reference* for a list of facility and priority values. Entries in the configuration file determine the destination for each error message based on these values. Destinations can be a file, user ID, or the **syslogd** daemon on another machine. We suggest that error messages be logged locally rather than forwarded to a remote **syslogd** because of the increased network traffic. File collections can be used to maintain consistent configuration of the syslog facility.

The format of a syslog log file is:

```
MMM DD HH:MM:SS node_name resource[pid]: msg
```

Where:

MMM DD HH:MM:SS	Timestamp (month day hour:minute:second)
node_name	The name of the node that the error occurred on
resource	The name of the failing system

pid	The optionally logged process ID of the failing resource.
msg	A free form error message.

Errors logged by SP components will contain in the message section the following additional information pertaining to the logging resource:

LPP	LPP name
Fn	filename
SID	SID_level_of_the_file
L#	Line number or function

From SMIT

The fastpath invocation for the Generate a Syslog Report menu is:

```
smit spsyslrpt
```

From the Command Line

To report to the local node all records logged by **ftp** for all syslog log files on nodes in the current system partition, enter:

```
psyslrpt -a -r ftp
```

To report all records that logged to files selected for the daemon and user facilities starting on March 3 and to report the records to the local node from nodes host1 and host2, enter:

```
psyslrpt -w host1,host2 -f user,daemon -s 03030000
```

For complete details on the **psyslrpt** command, refer to the *PSSP: Command and Technical Reference*.

Trimming BSD syslog Log Files

The size of syslog log files is not configurable and will continue to grow until manually trimmed.

From SMIT

The fastpath invocation for the Trim Syslog Log Files menu is:

```
smit spsyslclr
```

From the Command Line

To trim all records older than 30 days from the log file **/var/adm/msgs** on the local node, enter:

```
psyslclr -y 30 -l /var/adm/msgs
```

To trim all records from all log files found in the alternate syslog configuration file
| **/etc/syslog.conf**, enter:

```
| psyslclr -g /etc/syslog.conf -y 0
```

Note: The **syslogd** daemon is stopped during the trimming process, then restarted with either the default configuration file or an alternate file, if used (**-g** option). For complete details on the **psyslclr** command, refer to the *PSSP: Command and Technical Reference*.

psyslclr can be added as a **crontab** entry for performing scheduled syslog trimming. On the control workstation, **psyslclr** is used to trim daemon facility messages older than six days. This is done in **/usr/lpp/ssp/bin/cleanup.logs.ws**, which is run from the control workstation's **crontabs** file. (Refer to Chapter 13, "Maintaining the crontabs File" on page 217 for more information.)

Viewing Error Logs

You can view error log data.

From SMIT

To access the General Log Viewing SMIT menu, enter:

```
smit splogview
```

From the Command Line

To cause the contents of each file entry and output of each command entry on the target nodes in the log table **amd.tab** to be displayed to stdout of the node the **splm** command is executed on, enter:

```
splm -a view -t /spdata/sys1/logtables/amd.tab
```

For complete details on the **splm** command, refer to the *PSSP: Command and Technical Reference*.

Archiving Error Logs

Error log archives can be created, removed, or gathered to a central location where they can be optionally written to a tape device or mailed to another location.

From SMIT

To access the Archive Logs SMIT menu, enter:

```
smit sparchive
```

Creating Archives

From SMIT

The fastpath invocation for the Create Archives menu is:

```
smit spcreate_archive
```

From the Command Line

To create an archive on each target node under directory **/var/archives/arch_weekly.tab**, enter:

```
splm -a archive -t /spdata/sys1/logtables/weekly.tab -c -d /var/archives
```

Removing Archives

From SMIT

The fastpath invocation for the Remove Archives menu is:

```
smit spremove_archive
```

From the Command Line

To remove all files and directories under and including **/var/archives/arch_weekly.tab**, enter:

```
splm -a archive -t /spdata/sys1/logtables/weekly.tab -r -d /var/archives
```

Gathering Archives

From SMIT

The fastpath invocation for the Gather Archives menu is:

```
smit spgather_archive
```

From the Command Line

To gather the compressed tar files created on each target node under directory **/var/archives/arch_weekly.tab** to the directory **/var/logrepos** on the local node.

```
splm -a gather -k archive -t /spdata/sys1/logtables/weekly.tab \
-d /var/archives -l /var/logrepos
```

For complete details on the **splm** command, refer to the *PSSP: Command and Technical Reference*.

Collecting System Data for IBM Service

Service collections can be created, removed and gathered in the same manner as the archive functions with the addition of interacting with the AIX command **snap** to gather additional system information. The default top level directory for service collections is **/tmp** and this path will end with **srvc**_*log_table_name*.

From SMIT

To access the Collect Logs for Service SMIT menu, enter:

```
smit spcollect
```

Creating Service Collections

From SMIT

The fastpath invocation for the Create Service Collections menu is:

```
smit spcreate_collect
```

From the Command Line

In the following example service collections are created using table **ssp.tab**. **snap -gfk** will be called to gather general system information, file system information and kernel information. Additional log and system data designated in the **ssp.tab** table will be collected under the other directory created by **snap**. The *nodename*.**tar.Z** compressed tar file will be created.

```
splm -a service -t /spdata/sys1/logtables/ssp.tab -p 'gfk' -c
```

Removing Service Collections

From SMIT

The fastpath invocation for the Remove Service Collections menu is:

```
smit spremove_collect
```

From the Command Line

In the following example, the service collections that were created using table **ssp.tab** are removed:

```
splm -a service -t /spdata/sys1/logtables/ssp.tab -r
```

Gathering Service Collections

From SMIT

The fastpath invocation for the Gather Service Collections menu is:

```
smit spgather_collect
```

From the Command Line

In the following example the compressed tar files from the nodes in table **ssp.tab** are gathered to the local node and written to tape device **/dev/rmt0**. The **-s** flag specifies to stagger the process by gathering the file from one node, writing it to tape, then removing it before moving onto the next node. This provides a method for gathering all the compressed tar files to a tape or disk device, or mailing them, without requiring disk space on the local node for all the service tar files.

```
splm -a gather -k service -t /spdata/sys1/logtables/ssp.tab -d /tmp -s -o /dev/rmt0
```

For complete details on the **splm** command, see the book *PSSP: Command and Technical Reference*.

For information on the **snap** command, see the book *IBM AIX Commands Reference*.

The Communications Low-Level Application Programming Interface

Chapter 30. Understanding the Communications Low-Level Application Programming Interface (LAPI)

This chapter introduces you to the concepts and use of the Communications Low-level Application Programming Interface (LAPI).

Introducing the LAPI

The LAPI is a non-standard application programming interface designed to provide optimal communication performance on the SP Switch. It is based on an *active message* programming mechanism that provides a one-sided communications model (that is, one process initiates an operation and the completion of that operation does not require any other process to take a complementary action). The LAPI library provides the functions **PUT**, **GET**, and a general *active message* function that allows programmers to supply extensions by means of additions to the notification handlers. The LAPI is designed for use by libraries and power programmers for whom performance is more important than code portability.

Why Use the LAPI?

The LAPI provides the following advantages:

- Performance – The LAPI provides basic function for optimal performance. It is designed to especially provide low latency on short messages.
- Flexibility – The LAPI's one-sided communications model provides flexibility because the completion of an operation by one process does not require any other process to take a complementary action. Also, the LAPI provides a more primitive interface (than either MPI or IP) to the SP Switch, giving the programmer the choice of how much additional communications protocol needs to be added.
- Extendibility – The LAPI supports programmer-defined handlers that are invoked when a message arrives. Programmers can customize the LAPI to their specific environments.

Some general characteristics of the LAPI software are the following:

- Reliability – using the LAPI guarantees delivery of messages. Errors not directly related to the application are not propagated back to the application.
- Flow control.
- Support for large messages.
- Non-blocking calls.
- Interrupt and polling modes.
- Efficient exploitation of switch function.
- Ordering is not guaranteed.

General LAPI Functions

LAPI functions are divided into three parts:

1. A basic *active message* infrastructure that allows programmers to install a set of handlers that are invoked and executed in the address space of a target process on behalf of the process originating the active message. This generic interface allows programmers to customize the LAPI function to their unique environment.
2. A set of defined functions that is complete enough to satisfy the requirements of most programmers. These defined functions make the LAPI more usable and at the same time lend themselves to efficient implementation because their syntax and semantics are known.
3. A set of control functions for the initialization and eventual orderly shutdown of the LAPI layer.

Understanding the LAPI

To help you achieve a fuller understanding of the LAPI, this section presents further details on the active message infrastructure and the defined set of functions. In addition, concepts important to understanding the LAPI are explained.

The Active Message Infrastructure

The underlying infrastructure that was selected for the LAPI is referred to as the active message. It has the following characteristics:

- The active message includes the address of a user-specified handler. When the active message arrives at the target process, the specified handler is invoked and executes in the address space of the target process.
- The active message optionally may also bring with it the user header and data from the originating process.
- Operations are unilateral in the sense that the target process does not have to take explicit action for the active message to complete.
- Storage buffers for arriving data need to be provided by the invoked handler.

Writing Handlers

The ability for programmers to write their own handlers provides a generalized, yet efficient, mechanism for customizing the interface to one's specific requirements. The user is responsible for protecting shared structures and buffers where necessary by using the locking structures available in the AIX p-threads library.

The LAPI supports messages that can be larger than the size supported by the underlying SP Switch subsystem. Therefore, the data sent with the active message may arrive at the target in multiple packets and, further, these packets can arrive out of order. This situation places some requirements on how the handler is written.

When the active message brings with it data from the originating process, the architecture requires that the handler be written as two separate routines:

1. A *header handler* function. This function is specified in the active message call. It is called when the message first arrives at the target process and provides the LAPI dispatcher (the part of the LAPI that deals with the arrival of messages and invocation of handlers) with the address of where to copy the

arriving data, the address of the optional *completion handler*, and a pointer to the parameter that is to be passed to the completion handler.

2. A *completion handler* that is called after the whole message has been received.

An Example of LAPI Active Message Function

In this example, a programmer writes a handler for the LAPI active message interface. See the book *PSSP: Command and Technical Reference* for more information on the **LAPI_Amsend** subroutine.

1. The desired function (accumulate) is to add a vector (S) to another (D) on the target node and put the results in the vector at the target:

   ```
   D[0..N-1] = D[0..N-1] + S[0..N-1]
   ```

   where, S[N] is a vector of length N in the address space of the origin process (*origin_process*) D[N] is a vector of length N in the address space of the target process (*target_process*)

2. The generic active message call is defined as **LAPI_Amsend** (*hndl, tgt, hdr_hdl, uhdr, uhdr_len, udata, udata_len, tgt_cntr, org_cntr, cmpl_cntr*)

3. Before making the active message call, you must obtain the address of the target counter (*target_cntr_addr*) and the address of the header handler to be executed on the target process (*accumulate_addr*). The address of the header handler is obtained by the **LAPI_Address** function.

4. Initialize the *udhr* based on the header expected by *accumulate*. For example, the structure of *udhr* could be:

   ```
   typedef struct {
      void *target_addr;
      uint length;
   } put_add_hdr_t;

   put_add_hdr_t uhdr;

   uhdr.target_addr = D;
   uhdr.length = N;
   ```

5. Make the specific call

   ```
   LAPI_Amsend (hndl, target_process, accumulate_addr,
   &uhdr, sizeof(put_add_hdr_t), &S[0],
   N*sizeof(S[0]), target_cntr_addr, &origin_cntr, &completion_cntr)
   ```

6. When this message is received at the target (assuming that the entire origin data is contained within a packet), the *accumulate* handler you specified is invoked by the dispatcher. The structure of the header handler is:

   ```
   void *header_handler (lapi_handle_t hndl, void *uhdr,
      uint uhdr_len, uint msg_len, completion_handler_t,
      *completion_handler, void *user_info)
   ```

   The structure of the completion handler is:

   ```
   void completion_handler (lapi_handle_t hndl,
      void *user_info)
   ```

7. If any state information about the message is required by the completion handler, the information required must be saved in a user buffer by the header handler. The header handler passes the address of this buffer to the dispatcher

through the parameter *user_info*. The dispatcher uses this pointer as a parameter (*user_info*) for the completion handler.

8. For this example operations performed at the target process are:

   - Within the dispatcher:
     a. The LAPI header is read.
     b. *uhdr* and *uhdr_len* are extracted from the LAPI header.
     c. The header handler is invoked.

     ```
     buf = (*accumulate_addr)(hndl, uhdr, uhdr_len, msg_len,
            &completion_handler, &user_info);
     ```

     d. *udata* is copied into *buf*.
     e. The completion handler is invoked.

     ```
     (*completion_handler)(&hndl, user_info);
     ```

   Note: If the message was not contained within a packet, the LAPI layer will save the necessary information and will invoke the completion handler after all the *udata* has arrived and copied into *buf*

   - User-defined functions:
     – Header handler:

     ```
     accumulate(hndl, uhdr, uhdr_len, msg_len, completion_handler, user_info)
     {
        buf = addr where incoming data should be buffered
        save (target_addr=D, length=N, buf) in user_info
        completion_handler = complete_accumulate
        return buf
     }
     ```

     – Completion handler:

     ```
     complete_accumulate (hndl, user_info)
     {
        retrieve required data (namely D,N and buf) from user_info;
        for (i=0; i<N; i++) D[i]=D[i]
          + buf [i];
        return
     }
     ```

The accumulate handler is the header handler and is called by the LAPI layer when the message first arrives at the target process. The header handler saves the information required by *complete_accumulate* (*target_addr*, *length*, and *buf*) in *user_info* and passes back a pointer to the *complete_accumulate* handler as *user_info*. Additionally, the header handler returns address of a buffer *buf*.

Large active messages are generally transferred as multiple packets. In this case the LAPI layer stores the incoming data in the packets as they arrive into *buf*. When all the data has been received, it calls the *complete_accumulate* function which uses *user_info* to access the two vectors, adds them and stores them at the desired location. After the return from the *complete_accumulate* routine, the LAPI layer increments *tgt_ctr*. The *origin_cntr* increments when it is safe to return the origin buffer back to the user.

The *cmpl_cntr* increments after the completion handler has completed execution. The *cmpl_cntr*, therefore, is a reflection, at the origin, of the *tgt_cntr*.

The Defined Set of Functions

Fundamentally, the defined set of functions for the LAPI provides a Remote Memory Copy (RMC) interface. The primary characteristics of the defined set of functions provided by LAPI are:

- The basic data transfer operations are memory to memory copy operations that transfer data from one virtual address space to another virtual address space.
- The operations are unilateral. That is, one process initiates an operation and the completion of the operation does not require any other process to take some complementary action. (This is unlike a send and receive operation, where a send requires a complementary receive with matching parameters to be posted for completion.)
- The operations support both “pull” and “push”. The **LAPI_Get** operation copies data from the address space of the target process into the address space of the origin process. The **LAPI_Put** operation copies data into the address space of the target process from the address space of the origin process.
- The initiating process specifies the virtual address of both the source and destination of the data (unlike a send and receive process where each side specifies the address in its own address space). To avoid the limitation of requiring that the address maps on the different processes be identical, the LAPI provides the **LAPI_Address_init** mechanism by which the different communicating processes can exchange information regarding the address map of shared data objects.
- Because data transfer operations are unilateral and no synchronization between the two processes is implied, additional primitives are provided for explicit process synchronization when it is necessary for program correctness.
- Vector data transfer functions help you transfer noncontiguous data more efficiently.
- Functions are provided to detect completion and to enforce ordering.

Important LAPI Concepts

To use the LAPI, it is important to understand the following concepts:

- Origin and target
- Blocking and non-blocking calls
- Completion of communication operation
- Message ordering and atomicity
- Error handling
- Progress

Origin and Target

Origin denotes the task (or process or processor) that initiates a LAPI operation (**PUT**, **GET**, or *active message*.). *Target* denotes the other task whose address space is accessed. Although multiple tasks may run on a single node, it is convenient to think of each task as running on a different node. Therefore the origin task may also be referred to as the *origin node* and the target task as the *target node*. The origin and target can be the same for any of the calls, but if the origin and target data areas overlap, the results are undefined.

Blocking and Non-Blocking Calls

A blocking procedure is one that returns only after the operation is complete. There are no restrictions on the reuse of user resources.

A non-blocking procedure is one that may return before the operation is complete and before the user is allowed to reuse all the resources specified in the call. A non-blocking operation is considered to be complete only after a completion testing function, such as **LAPI_Waitcntr** or **Lapi_Getcntr**, indicates that the operation is complete.

Completion of Communication Operation

A communication operation is considered to be complete, with respect to the buffer, when the buffer is reusable.

A **PUT** is complete with respect to the *origin* buffer when the data has been copied out of the buffer at the origin and may be overwritten. A **GET** is complete with respect to the *origin* buffer when that origin buffer holds the new data that was obtained by **GET**.

A **PUT** is complete with respect to the *target* buffer when the new data is available at the target buffer. A **GET** is complete with respect to the *target* buffer when the data has been copied out of the buffer at target and the target task may overwrite that buffer.

Communication Behaviors: Two communication behaviors support two different definitions of “completion”:

- In **standard** behavior, a communication operation is defined as complete at the *origin* task when it is complete with respect to the *origin* buffer; it is complete at the *target* task when it is complete with respect to the *target* buffer.
- In **synchronous** behavior, a communication operation is defined as complete at the *origin* task when it is complete with respect to both the *origin* buffer and *target* buffer. It is complete at the *target* task when it is complete with respect to the *target* buffer.

The LAPI defines both standard and synchronous behaviors for **PUT** operations. The LAPI defines only synchronous behavior for **GET** operations.

Message Ordering and Atomicity

Two LAPI operations that have the same *origin* task are considered to be ordered with respect to the *origin* if one of the operations starts after the other has completed at the *origin* task. Similarly, two LAPI operations that have the same *target* task are considered to be ordered with respect to the *target* if one of the operations starts after the other has completed at the *target* task. If two operations are not ordered, they are considered concurrent. The LAPI provides no guarantees of ordering for concurrent communication operations. The LAPI does provide mechanisms which an application can use to guarantee order.

As an example, consider the case where a node issues two standard behavior **PUT** operations to the same target node, where the targets overlap. These two operations may complete in any order, including the possibility of the first **PUT** overlapping the second, in time. The contents of the overlapping region will be undefined, even after both **PUT**s complete. Using synchronous behavior for both **PUT** operations, (waiting for the first to complete before starting the second) will ensure that the overlapping region contains the result of the second after both **PUT**s have completed.

Error Handling

If an error occurs during a communications operation, the error may be signaled at the origin of operation, or the target or both. Some errors may be caught before the communication operation begins, and these will be signaled at the origin. However, some errors will not occur until the communication is in progress (a segmentation violation at the target, for example); these may be signaled at either or both ends of the communication.

Progress

All LAPI operations are unilateral by default and can complete successfully or fail, independent of the actions of other tasks. Specifically, a LAPI operation to a particular target should complete even if the target is stuck in an infinite loop: that is, when the target process is in interrupt mode.

Chapter 31. Using the LAPI

In general, LAPI functions:

- Are non-blocking calls
- Provide both polling and interrupt mode
- Signal completion by incrementing counters at each end
- Provide both C and Fortran bindings

Complementary functions provide for checking completion of operations and for enforcing relative ordering if required. Additionally, functions allow processes to exchange addresses that will be used in LAPI operations.

Specific LAPI Functions

The LAPI provides the following specific functions.

Active Message

The active message function (**LAPI_Amsend**) is a non-blocking call that causes the specified active message handler to be invoked and executed in the address space of the target process. Completion of the operation is signaled if counters are specified. Both standard and synchronous behaviors are supported. The **LAPI_Amsend** function provides two counters (*org_cntr* and *cmpl_cntr*) which can be used to provide the two behaviors. The *org_cntr* increments when the origin buffer can be reused (standard). The *cmpl_cntr* increments after the completion handler has completed execution (synchronous).

Data Transfer

Data transfer functions are non-blocking calls that cause data to be copied from a specified region in the origin address space to the specified region in the target address space (in the case of a **LAPI_Put** operation) or from a specified region in the target address space to a specified region in the origin address space (in the case of a **LAPI_Get** operation). Completion of the operation is signaled if counters are specified. Both standard and synchronous operations are supported for **PUT**. Only synchronous operation is possible in the case of **GET**. Standard **PUT** is provided by incrementing the *org_cntr* when the origin buffer can be reused. Synchronous **PUT** is provided by incrementing the *cmpl_cntr* after the data has been written into the target buffer. The **LAPI_Getcntr** (or **LAPI_Waitcntr**) function should be used in conjunction with the *org_cntr* and *cmpl_cntr* counters to guarantee the respective standard and synchronous behavior of the LAPI **PUT** operations.

Vector Data Transfer

The LAPI vector functions are provided to help you transfer noncontiguous data more efficiently. Without these functions you would have used a series of data transfer functions, one for each contiguous chunk of data, resulting in pipelining overhead, or you would have copied the various chunks of data into a contiguous buffer before using LPI to transfer the data, resulting in copy overhead. The general I/O vector transfer function and the general strided transfer function use the following I/O vector structure:

```
typedef      struct          {
             lapi_vectype_t   vec_type;       /* operation code */
             uint             num_vecs;       /* number of vectors */
             void             **info;         /* vector of information */
             uint             *len;           /* vector of lengths */
} lapi_vec_t;
```

where*vec_type*, *num_vecs*, *info*, and *len* are variables to be replaced by the respective values.

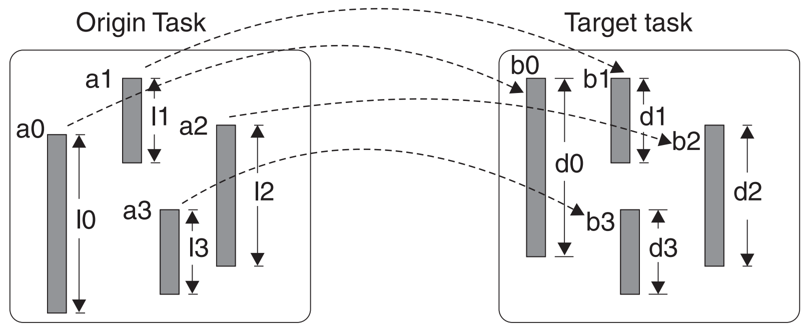
Properties

The following properties apply in all vector data transfers:

- For highest efficiency, start each buffer at a doubleword-aligned address and have the length of the data in each contiguous block be a multiple of 8.
- In any vector call, the *vec_type* value of the vector at the origin need not be the same as the *vec_type* value at the target.
- The total amount of data specified in the origin vector must be identical to the total amount of data specified in the target vector.

General I/O Vector Transfer

Figure 41 shows the general I/O vector transfer case.



num_vecs=4	num_vecs = 4;
info[0] = a0;	info[0] = b0;
info[1] = a1;	info[1] = b1;
info[2] = a2;	info[2] = b2;
info[3] = a3;	info[3] = b3;
len[0] = l0;	len[0] = d0;
len[1] = l1;	len[1] = d1;
len[2] = l2;	len[2] = d2;
len[3] = l3;	len[3] = d3;

Figure 41. Transfer of Noncontiguous Data using LAPI General I/O Vector Transfer

In this case, the respective values for the **lapi_vec_t** structure variables are as follows:

vec_type must be **LAPI_GEN_IOVECTOR**

num_vecs is the number of vectors in the *info* and *len* arrays. The value at the origin can be different from the value at the target.

info is an array that contains buffer addresses representing the starting address for each of the vectors.

len is an array that contains the length in bytes for each vector respectively.

Symmetric I/O Vector Transfer

This is a special case of the general I/O vector transfer. In this case, the respective values for the **lapi_vec_t** structure variables are as follows:

vec_type must be **LAPI_IOVECTOR_SYMMETRIC**

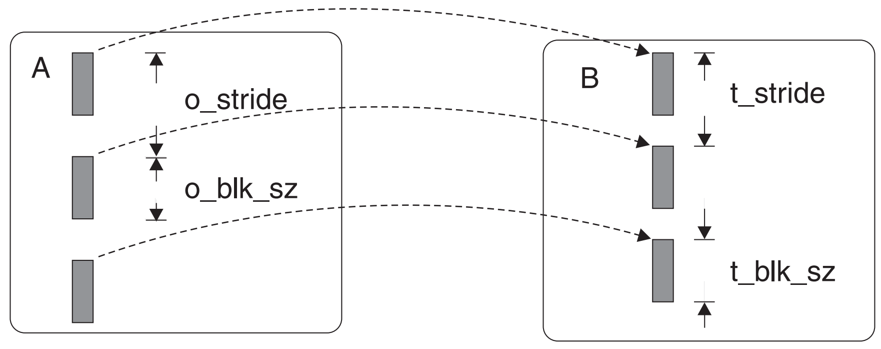
num_vecs is the number of vectors in the *info* and *len* arrays. In this case, the value must be the same at the origin and the target.

info is an array that contains buffer addresses representing the starting address for each of the vectors.

len is an array that contains the length in bytes for each vector respectively. The value of *len[i]* must be the same at the origin and the target for 0 < *i* < *num_vecs*.

General Strided Transfer

Figure 42 shows the general strided data transfer case.



```
num_vecs=3;              num_vec=3;
info[0] = A;             info[0] = B;
info[1] = o_blk_sz;      info[1] = t_blk_sz;
info[2] = o_stride;      info[2] = t_stride;
len = dont_care          len = dont_care
```

Figure 42. Transfer of Noncontiguous Data using LAPI General Strided Transfer

In this case, the respective values for the **lapi_vec_t** structure variables are as follows:

vec_type must be **LAPI_GEN_STRIDED_XFER**

num_vecs is the number of vectors in the *info* array. The value at the origin can be different from the value at the target.

info is an array that contains buffer addresses representing the starting address for each of the vectors. In this case, the array has the following special use entries:

- *info*[**0**] contains the starting address of the strided vectors.
- *info*[**1**] contains the size of each block in bytes.
- *info*[**2**] contains the stride size in bytes.

len is not used in this case.

Synchronizing

The **LAPI_Rmw** function is used to synchronize two independent operations such as two processes sharing a common data structure. The operation is performed at the target process and is atomic. The operation takes a variable from the origin and performs one of four selected operations on a variable from the target and replaces the target variable with the results of the operation. The original value of the target variable is returned to the origin. **LAPI_Rmw** provides four different read/modify/write operations:

- **SWAP**
- **COMPARE_AND_SWAP**
- **FETCH_AND_ADD**
- **FETCH_AND_OR**

Completion is signaled at the origin if the counter is specified.

Completion Checking

The following counter functions provide the means for a process to manage the completion state of the LAPI operations.

- **LAPI_Waitcntr** - Wait on a counter to reach a specified value and return when the counter is equal to or greater than that value (blocking)
- **LAPI_Getcntr** - Get the current value of a specified counter (non-blocking)
- **LAPI_Setcntr** - Set the counter to a specified value

These functions also provide an efficient means to order the flow of LAPI operations or the use of certain user managed resources (for example, buffers). For example, a series of **PUT**s to a single target and buffer requires that the contents of the buffer at the target remains in step with the order of execution of the **PUT**s at the origin. Using the *cmpl_cntr* counter in the **LAPI_Put** function in conjunction with the **LAPI_Waitcntr** function provides the necessary ordering.

Ordering

LAPI-Fence and **LAPI_Gfence** operations provide a means to enforce the order of execution of LAPI functions. LAPI functions initiated prior to these fencing operations are guaranteed to complete before LAPI functions initiated after the fencing functions. **LAPI_Fence** is a local operation which is used to guarantee that all LAPI operations initiated by the local process and the same process thread are complete. **LAPI_Gfence** is a collective operation involving all processes in the parallel program. **LAPI_Gfence** provides a barrier operation for the parallel program. Both **LAPI_Fence** and **LAPI_Gfence** operations are a data fence that guarantee that the data movement is complete. These are not an operation fence which would need to include active message completion handlers completing at the target.

Progress

The **LAPI_Probe** function is used in polling mode to transfer control to the communication subsystem in order to make progress on arriving messages.

Address Manipulation

The **LAPI_Address_init** collective operation allows processes to exchange operand addresses of interest. Such function is required if the processes do not have identical address maps. The **LAPI_Address** is used by Fortran programs when an address needs to be stored in an array. In Fortran there is no concept of "address" (as there is in the C language) and this function gives that ability to Fortran.

LAPI Setup

LAPI_Init and **LAPI_Term** operations are used to initialize and terminate the communication structures required to effect LAPI communications for a specific instance of LAPI. **LAPI_Init** returns a unique handle which is used to associate a communication channel with the LAPI instance. This handle is subsequently passed as a parameter to each of the other LAPI functions. The **LAPI_Term** function is used to terminate a specific instance of LAPI.

Error Handling and Messages

The **LAPI_Init** function provides a means for the user of LAPI to register an error handler. This error handler is specified as part of the *lapi_info* structure parameter which is passed to the **LAPI_Init** function. The **LAPI_Msg_String** function provides the means to translate a LAPI call return code value (integer) into a message string.

LAPI Environment

The **LAPI_Qenv** function is used to query the state of the LAPI communications subsystem. The **LAPI_Senv** function allows the programmer to specify the value of some of the LAPI communications subsystem's environment variables. An important value that can be specified is the interrupt state. The interrupt state is set by specifying **INTERRUPT_SET** as **on** (for interrupt mode) or **off** (for polling mode). The default setting for **INTERRUPT_SET** is **on**.

The LAPI Execution Model

The goal of LAPI is to provide a threads-safe environment and support an execution model that allows for maximum execution concurrency within the LAPI library.

Using the setup function (**LAPI_Init**), a user process establishes a LAPI context. Within a LAPI context, the LAPI library is threads-safe, and multiple threads can make LAPI calls within the same context. The different calls can execute concurrently with each other and with the user threads. However, in reality execution concurrence among these calls is limited by the locking required with LAPI to maintain integrity of its internal data structures and the need to share a single underlying communication channel.

As with any multi-threaded application, coherence of user data is the responsibility of the user. Specifically, if two or more LAPI calls from different threads can execute concurrently and if they specify overlapping user buffer areas, then the result is undefined. It is the responsibility of the user to coordinate the required synchronization between threads that operate on overlapping buffers.

The user application thread, as well as the completion handlers, cannot hold mutual exclusion resources before making LAPI calls; if they do, it is possible to run into deadlock situations.

Because user-defined handlers can be called concurrently from multiple threads, it is the user's responsibility to make them threads-safe.

The application thread, notification thread and the completion handler thread are shown in Figure 43.

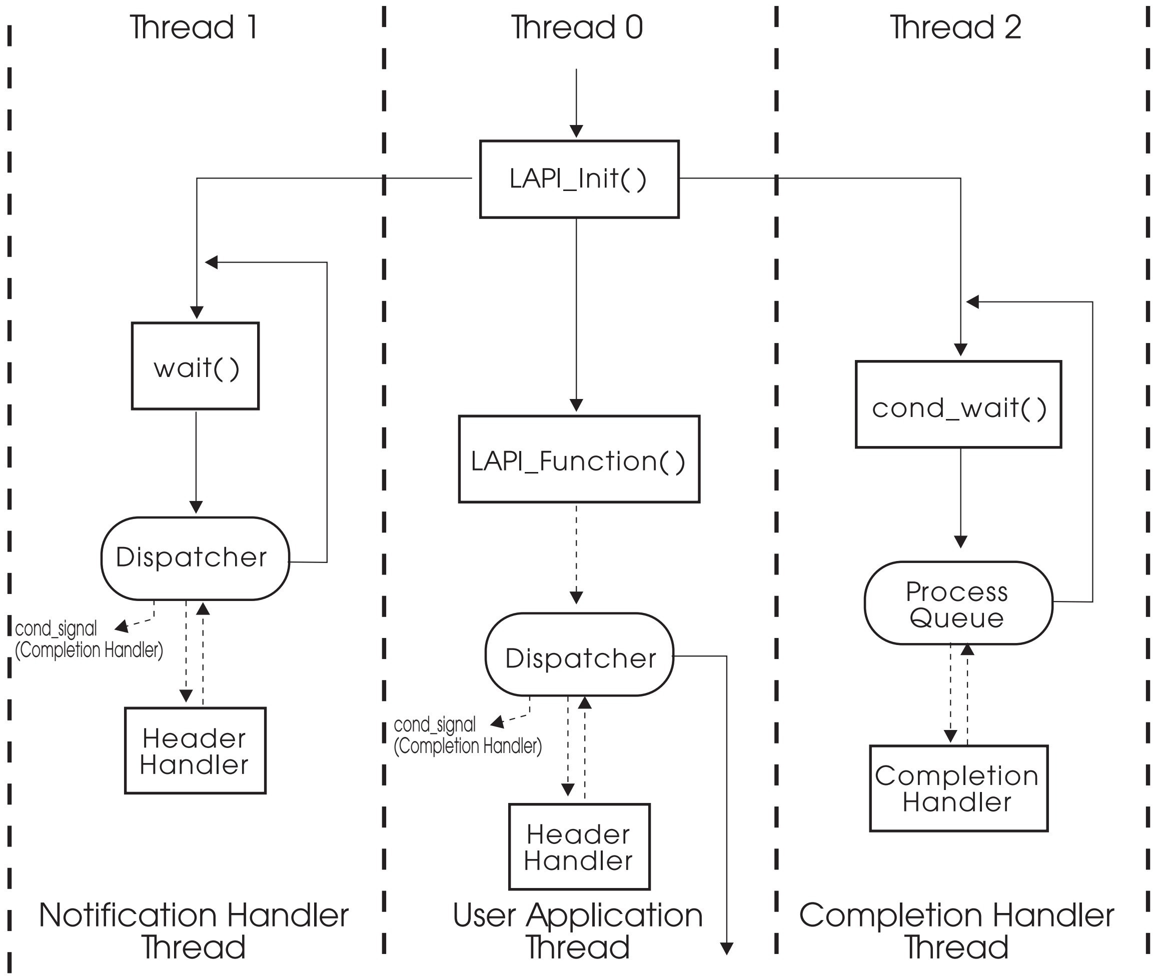


Figure 43. A LAPI Thread Model

Threads 0 and 1 (the application thread and the notification thread) attempt to invoke the LAPI dispatcher whenever possible; in this way, progress on incoming and outgoing messages can be made while minimizing additional overhead. Most LAPI calls (though not all) made by the application thread also result in the LAPI dispatcher being automatically run. The notification thread waits in the Kernel for the occurrence of a notification event. When an event occurs, the Kernel wakes up the waiting thread. As shown in Figure 43, after the notification thread returns from waiting in the Kernel, it invokes the LAPI dispatcher.

The LAPI Dispatcher is the central control point that orchestrates the invocation of functions and threads necessary to process outstanding incoming and outgoing LAPI messages.

The LAPI Dispatcher can run from the application's user's thread, from the notification thread or from the completion handler thread. Locking is used to ensure that only one instance of the dispatcher runs at a time to maintain integrity. On incoming messages, the LAPI dispatcher manages the reassembly of data from different packets (which might arrive out-of-order) into the specified buffer, and then invokes the completion handler if necessary.

Thread 2 is created by **LAPI_Init** to execute completion handlers associated with active messages. Completion handlers are written by users and can make LAPI function calls which in turn will invoke the LAPI Dispatcher. The completion handler thread processes work from the completion handler queue. When the queue is empty the thread waits using a **pthread_cond_wait()**. If an active message (**LAPI_Amsend**) includes a completion handler, the dispatcher queues a request on the completion queue after the whole message has arrived and has been reassembled in the specified buffer; the dispatcher then sends a **pthread_cond_signal** to the completion handler thread. If this thread was in a wait state it will begin processing the completion handler queue, otherwise, if it was not waiting, the thread signal is ignored.

LAPI handlers are not guaranteed to execute one at a time. Note that LAPI calls can execute concurrently within the origin or target or both. The same restrictions stated previously about not holding on to mutual exclusion resources when making LAPI calls still applies.

This discussion of a threads-safe environment and maximum execution concurrence within the LAPI library applies to both the polling and interrupt modes. In polling mode any calls to the communication library attempt to make progress on the context specified in the call. Further, the function **LAPI_Probe** is provided to allow applications to explicitly check for and handle incoming messages.

The execution model of the handlers consists of the following events:

Event	**Action**
Message Arrival	Copies the message from the network into the appropriate data access memory space.
Interrupt / Poll	Causes an interrupt if required, based on the mode.
Dispatcher Start	Invokes the dispatcher.
New Message Packet	Checks the LAPI header and determines (by checking the receive state message reassembly table) if the packet is part of a pending message or if it is a new message. Calls the header-handler function for the first packet of a new message.
Return from Header-Handler	If the message is contained in more than one packet, the LAPI Dispatcher will log that there is a pending message, save the completion handler address, and save the user's

buffer address to be used during the message reassembly of pending message packets.

Pending Message Packet
Copies the message to the appropriate portion of the user buffer specified through the header-handler. If the packet completes the message, the dispatcher queues the completion handler; otherwise the dispatcher returns to check for message arrivals.

Completion Handler
When the completion handler is executed, (after the return from the completion handler) updates the appropriate target counter before continuing.

Allocating Buffers

1. The user allocates as many buffers per origin as wanted.
   - Rule: At origin, if the target buffer allocation is exhausted, wait for the counter of previous requests.
   - Example: Use >= *P* buffers (one per origin). At origin with one request pending. Wait on counter before issuing next request.
2. If the header handler blocks, no further progress is made, including messages pending (that is, the communications adapter is stalled).

Caution: The user is allowed to make LAPI calls from within the completion handler. However, the users should exercise caution when writing completion handlers which do long computation and then issue LAPI calls. The long computation might cause completion handler queues to fill up if multiple active messages are sent before these handlers complete. This can cause fetch deadlocks. In such cases, users should fork a separate thread from within the completion handler and have the forked thread make LAPI calls to eliminate the possibility of a fetch deadlock occurring.

Executing LAPI Programs

The LAPI communications application programming interface must be used in conjunction with the IBM Parallel Environment for AIX (PE) product. Specifically the Parallel Operating Environment (POE) component of PE is used to compile and run LAPI parallel programs. POE also provides support for parallel programs to use the Message Passing Interface (MPI) both separately and in combination with the LAPI. The publication *IBM Parallel Environment for AIX: Operation and Use* provides detailed information about using the POE.

Compiling LAPI Programs

As with a serial application, you must compile a parallel C, C++, or Fortran program before you can run it. Instead of using the **cc_r**, **xlC_r**, or **xlf** commands, however, you use the commands **mpcc_r**, **mpCC_r**, or **mpxlf_r**, which support programs using the threaded LAPI library. The **mpcc_r**, **mpCC_r**, and **mpxlf_r** commands not only compile your program, but also link in the POE Partition Manager and PSSP Communication Subsystem (CSS) interfaces. When you later run the program, the CSS libraries will be dynamically linked with the executable program. Subroutines in these libraries enable POE's home node (the node from which the parallel program is invoked) to communicate with the parallel tasks, and tasks with each other.

The following table shows what to enter to compile a LAPI program.

To compile a C program	**mpcc_r program.c -o program**
To compile a C++ program	**mpCC_r program.C -o program**
To compile a Fortran program	**mpxlf_r program.f -o program**

Creating a Static Executable

Note: IBM suggests you avoid creating statically bound executables. If service is ever applied that affects any of the CSS libraries, you will need to recompile your application to create a new executable that will work with the new libraries. This could lead to a lot of work and might expose you to potential problems, which would be avoided if dynamic libraries are used.

The following is a sample make file:

```
COMPILER  = mpcc_r
CFLAGS    = -g

FCOMPILER = mpxlf_r
FFLAGS    = -g

STATIC = -bnso -bI:/usr/lib/syscalls.exp -bI:/usr/lib/threads.exp \
         -bI:/usr/lpp/ssp/css/libus/fs_ext.exp -lppe_r -lhal_r

all: Get Put Am Rmw Getf Putf Rmwf Amf Get_static

Get: Get.c
        $(COMPILER) $(CFLAGS) -v -o $@ $@.c

Getf: Getf.f
        $(FCOMPILER) $(FFLAGS) -v -o $@ $@.f

Put: Put.c
        $(COMPILER) $(CFLAGS) -v -o $@ $@.c

Putf: Putf.f
        $(FCOMPILER) $(FFLAGS) -v -o $@ $@.f

Am: Am.c
        $(COMPILER) $(CFLAGS) -v -o $@ $@.c

Amf: Amf.f
        $(FCOMPILER) $(FFLAGS) -v -o $@ $@.f

Rmw: Rmw.c
        $(COMPILER) $(CFLAGS) -v -o $@ $@.c

Rmwf: Rmwf.f
        $(FCOMPILER) $(FFLAGS) -v -o $@ $@.f

Get_static: Get.c
```

```
        $(COMPILER) $(CFLAGS) $(STATIC) -v -o $@
Get.c

clean:
        rm -rf Get Put Am Rmw Getf Putf Rmwf Amf Get_static
```

Running LAPI Programs

Before running your program, you need to set up your execution environment. There are a number of POE environment variables discussed throughout *IBM Parallel Environment for AIX: Operation and Use* and summarized in the “POE Environment Variables and Command-Line Flags” appendix of that book. LAPI programs must set the environment variable **MP_EUILIB** (or the command-line flag **-euilib**) to **us** (**us** is the User Space communication subsystem). The default setting for **MP_EUILIB** is **ip** (**ip** is the IP communication subsystem). The LAPI supports only User Space communication using the SP Switch. The LAPI does not support using the IP communication subsystem.

All other procedures for running a LAPI program using POE are common with the MPI programs and are described in *IBM Parallel Environment for AIX: Operation and Use*.

Specific LAPI Hints

The LAPI library uses the SIGBUS signal handler. If an application using LAPI also uses SIGBUS, the application's SIGBUS handler should be registered before the call is made to the **LAPI_Init** function.

The **LAPI_Senv** function should be used to enable error checking (**ERROR_CHK** should be set on) during application development and disabled (**ERROR_CHK** should be set off) for normal application use.

When the order of execution between any two LAPI functions within one task of a parallel program needs to be guaranteed, using **LAPI_Waitcntr** between the two LAPI functions will usually be more efficient than **LAPI_Fence**. **LAPI_Fence** requires that all LAPI operations initiated on the current thread before the **LAPI_Fence** be completed before any LAPI operation after the fence is allowed to start. **LAPI_Waitcntr** can be used to indicate the completion of a single LAPI function which had been initiated on the current thread before the **LAPI_Waitcntr**.

The scope of **LAPI_Fence** is per thread. For example, a **LAPI_Fence** which is issued from the completion handler thread will only guarantee that no LAPI operations initiated after the fence (on the completion handler thread) will start until all LAPI operations initiated before the fence have completed. In this case there are no guarantees about the order of LAPI operations initiated from the main application thread.

LAPI_Waitcntr can be used to indicate the completion of a single LAPI function which might have been initiated from an alternate thread (completion handler) within the same task. Therefore the possibility exists to use **LAPI_Waitcntr** to wait for the completion of another LAPI function which is initiated after the call to **LAPI_Waitcntr**.

LAPI_Waitcntr can be used to guarantee order of execution of **LAPI_Amsend** operations which are initiated from a single origin task. When **LAPI_Amsend**

operations use the *cmpl_cntr* counter, this counter is incremented after the completion counter (or header handler if a completion handler is not specified) has executed at the target task. **LAPI_Fence** and **LAPI_Gfence** do not provide an indication that **LAPI_Amsend** operations have completed execution at the target.

LAPI_Waitcntr is a blocking call. If a user prefers to avoid this blocking operation a program loop comprised of the sequence

```
LAPI_Getcntr
a check of the value returned from Get
LAPI_Probe
```

will provide an equivalent logical operation and provide the user with added flexibility.

| Before calling the **LAPI_Init** function, any unused fields of the `lapi_info_t`
| structure, the second parameter to **LAPI_Init**, must be set to zero.

LAPI_Init must be called before any thread (the main thread or the completion handler thread) can make a LAPI call. In addition to this, **LAPI_Address_init** or **LAPI_Gfence** should be the second LAPI call. These two functions provide a barrier which guarantees that all other LAPI tasks have initialized their LAPI subsystems and are ready to receive requests from remote tasks. Failure to provide these barrier functions might result in dropped switch packets, low performance at start-up and unnecessary switch congestion. The instance of the LAPI subsystem should be quiesced before **LAPI_Term** is called to terminate the LAPI instance. This can be done by calling **LAPI_Gfence** before **LAPI_Term**.

When one task of a parallel job (using POE) determines a condition which requires that all tasks of the parallel job be terminated, the task needs to send a process terminating signal (for example, **SIGTERM** or **SIGQUIT**) to itself. The POE daemon (**PMD**) which spawned that task will:

1. Catch **SIGCHILD**
2. Send a message to the POE “home node”
3. The POE “home node” broadcasts a message to all the **PMD**s to terminate the job
4. Each of the **PMD**s sends **SIGTERM** to their child process and waits for **SIGCHILD**
5. Each task termination is reported back to the “home node”
6. The complete POE job ends

General LAPI Hints

Programs using the LAPI library are compiled with the POE commands **mpcc_r**, **mpCC_r** and **mpxlf_r**. The user's program can (but is not required to) create threads. The POE commands also link a POE version of the standard re-entrant C library, **libc_r.a**, which allows synchronization of the tasks at exit. All the PE and CSS libraries are dynamic shared libraries, enhancing the portability of the user's application between operating system levels and machine types. **mpcc_r** invokes the re-entrant C compiler with the compiler option to include the threaded (re-entrant) libraries and to generate thread-aware code. **mpcc_r** links in the threaded LAPI library, including the threaded versions of the POE utility libraries.

A threaded program has more than one independent instruction stream, but all threads share the same address space, file, and environment variables.

Core Dumps

If a task produces a core file, it is written to an appropriately named subdirectory of the user's current directory. The partial dump produced by default does not contain the stack and status information for all threads; thus it is of limited usefulness in trying to diagnose hang conditions. It is possible to request AIX to produce a full core file, but such files are generally larger than permitted by AIX user limits. The communication subsystem alone generates more than 64MB of core information. Thus, if possible, use the attach capability of **dbx**, **xldb** or **pdbx** to examine the task while it is still running.

Hangs

Coordinating the threads in a task requires careful locking and signaling. Program deadlocks waiting on locks that haven't been released are common, in addition to the deadlock possibilities offered by improper use of the LAPI calls.

Use with Thread-Safe Libraries

A threaded LAPI program must meet the same criteria as any other threaded program. It must avoid using non-thread safe functions in more than one thread (for example, **strtok**). In addition, it must use only thread-safe libraries if library functions are called on more than one thread. AIX provides thread-safe versions of some libraries, such as the **libc_r.a** library. However, not all libraries have a thread-safe version. It is your responsibility to determine whether the libraries you use can be safely called by more than one thread.

AIX requires that threaded programs that include <pthread.h> put this include first, before includes for <stdio.h> or other system includes. This is because <pthread.h> defines some conditional compile variables that modify the code generation of subsequent includes, particularly <stdio.h>. Note that <pthread.h> is not required unless the file uses thread-related calls or data.

POE catches asynchronous signals that normally terminate a program (**SIGINT**, **SIGQUIT**, **SIGTERM**, **SIGDANGER**) and terminates the entire parallel job. In addition, POE catches synchronous signals (**SIGSEGV**, **SIGBUS**) that are specific to a thread, terminates the entire parallel job, and causes a core file to be written at the point of interrupt on that thread. Since it is possible for several threads to generate synchronous signals simultaneously, the POE signal handler blocks subsequent occurrences.

The stacksize for the main thread is set as a characteristic of the user (in **/etc/security/limits** which is maintained by SMIT). The user can set the stacksize of any additional threads created; the default is 96K. Thread stacks are allocated in the process heap.

The main program should **exit**, not just **pthread_exit**. **pthread_exit** might not terminate all threads. **exit** will result in all threads being terminated.

If the user's application is also using the MPI protocol, the threaded MPI library (**libmpi_r.a**) must be used. Use of the MPI signal library (**libmpi.a**) along with the LAPI library is not supported.

The AIX compilers support a flag **-qarch** that allows the user to target code generation to a particular processor architecture. While this option can provide performance enhancements on specific platforms, it inhibits portability, particularly between the Power and PowerPC machines. The LAPI library is not targeted to a particular architecture, and is the same on PowerPC and Power nodes.

Once the LAPI library is initialized, if the process forks, only the forking thread exists in the child process. The child process doing LAPI communications is not supported.

IBM Parallel Environment for AIX: Hitchhiker's Guide provides additional information which has applicability to running LAPI parallel jobs using POE.

Linking with Libraries Built with libc.a

Compiling a threaded LAPI program will cause the **libc_r.a** library to be used to resolve all the calls to the standard C library. If your program links with a library that has been built using the standard C library, it is still usable (assuming that it provides the necessary logical thread safety) under the following conditions:

- The library has been built using a reference to the C library shared object (this is the default, unless the **-bnso** flag was used to build it)
- The run-time library path resolves the file reference **libc.a** to the POE version of **libc_r.a**.

To explain further, the run-time library path for an executable is composed of the **AIX LIBPATH** environment variable concatenated with the library path string contained in the **a.out** file (and put there when the program was linked). All the shared libraries used by the executable must be found in the directories occurring in this string. Normally the **AIX LIBPATH** environment variable is empty, and the **cc** (**xlc**) compiler creates a string in which **/usr/lib** is the first entry. Thus, the executable looks for **/usr/lib/libc.a.** However, the **cc_r** (**xlc_r**) compiler creates a string starting with **/usr/lib/threads:/usr/lib**. Thus, the executable will look for **libc.a** in **/usr/lib/threads** first. And, in fact, there is exactly one member of **/usr/lib/threads**: **/usr/lib/threads/libc.a**, which is, however, a symbolic link to **/usr/lib/libc_r.a**! Thus, the executable looking for **libc.a** actually loads **libc_r.a**. Calls to symbols in **libc.a** are resolved by the second entry, **/usr/lib/libc_r.a**. Thus, all calls to the standard C library are resolved by the same library, providing a consistent internal state.

mpcc_r does the same sort of thing. **mpcc_r** puts **/usr/lpp/ppe.poe/lib/threads:/usr/lpp/ppe.poe/lib** in the executable's libpath string and expects **/usr/lpp/ppe.poe/lib/threads/libc.a** to be a symbolic link to **/usr/lpp/ppe.poe/lib/libc_r.a**

The **LIBPATH** environment variable can be set by the user directly. The current version of POE (Version 2.3) sets the default LIBPATH as follows: **LIBPATH=$MP_EUILIBPATH/$MP_EUILIB**, and expects that the **mpcc_r** command has caused **/usr/lpp/ppe.poe/lib** to be included in the **LIBPATH** search string.

Use of Segment Registers (-bmaxdata Restrictions)

The User Space LAPI library uses two segment registers of the 10 that are unassigned in the user's AIX process space. Thus, the user can use a maximum of 8 segments (**-bmaxdata=0x80000000**) for extended heap for large data arrays. The MPI library uses 3 segment registers. A program calling both the LAPI and MPI interfaces has a maximum of 5 segments available for shared memory or extended heap.

IBM suggests that you don't write threaded message passing programs until you are quite familiar with writing and debugging threaded single-task programs.

Chapter 32. LAPI Programming Examples

Active Message (C)

This C program is an example of the use of the LAPI active message call:

```
/*Am.c
**Example Program illustrating use of the LAPI Active Message Call
*/

#include <lapi.h>

#define A_MAX     2
#define I_MAX     10

typedef struct {                    /* header for active message handler */
     compl_hndlr_t *cmpl_hndlr;     /* pointer to completion handler */
     int uinfo;                     /* uinfo passed to -- */
} usrhdr_t;                         /* the completion handler */

volatile int cont=0;

/*
/** Function:     The completion handler for the active call.
**               This is invoked at the target after all the data
**               of the active message send (LAPI_Amsend) call have
**               reached the target.
** Parameters:   hndl  -> pointer to the handle for the LAPI context
**               param -> pointer to the user param (specified
**                        by user in the header handler function)
*/

void
do_get(lapi_handle_t *hndl, void *param)                              do_get
{
     int loop, rc;
     int *buf;

     buf = (int *) param;
     printf("In Completion Handler: Result of AM call\n");

     /* Print Updated buffer */
     for (loop=0; loop < I_MAX; loop++) {
         printf("val[%d] = %d\n", loop, buf[loop]);
     }

     cont= 1;
}

/*
** Function:    User's active messsage header handler. This is invoked
**              at the target when the active message first arrives
**              at the target
** Parameters:  hndl    ->     pointer to the handle for the LAPI
**                             context
**              uhdr    ->     pointer to the user header
**              uhdrlen ->     pointer to the length of the user
**                             header
**              msglen  ->     pointer to the length of the message
**              compl_hndlr -> pointer to the completion handler
**                              function pointer. This is to be set
**                              by the user in this function.  (CAN
**                              be NULL)
**              saved_info ->  pointer to the user_info.  This is set
**                              by the user in this function. This
**                              parameter is then passed to the
**                              completion handler when the completion
**                              handler is invoked.
*/

void *
hdr_hndlr(lapi_handle_t *hndl, void *uhdr, uint *uhdrlen, uint *msglen,
          compl_hndlr_t **cmpl_hndlr, void **saved_info)
{
    void          *buf;
    usrhdr_t      *vhdr;

    printf("In Header Handler\n");
    vhdr            = (usrhdr_t *) uhdr;
    *cmpl_hndlr      = (compl_hndlr_t *) vhdr->cmpl_hndlr;
    *saved_info      = (void *) vhdr->uinfo;
    buf             = (void *) vhdr->uinfo;

    return (buf);
}


int
main(int argc, char **argv)                                     main
{
    lapi_handle_t t_hndl;                 /* LAPI context handle - */
                                          /* returned */
    lapi_info_t   t_info;                 /* LAPI info structure */
    int           task_id,                /* My task id */
                  num_tasks;              /* Number of tasks in my */
                                          /* job */
    lapi_cntr_t   l_cntr;                 /* Origin counter */
    lapi_cntr_t   t_cntr;                 /* Target counter */
    lapi_cntr_t   c_cntr;                 /* Completion counter */
    int           t_buf[I_MAX];           /* Buffer to manipulate */
    void          *global_addr[A_MAX];     /* Array to store */
                                          /* t_buf addr from all the */
                                          /* tasks.  The size of this */
                                          /* array needs to each */
                                          /* number of tasks */
    void          *tgt_addr[A_MAX];        /* Array to store target */
                                          /* counter addr from all */
                                          /* the tasks. */
    void          *hndlr_addr[A_MAX];      /* Array to store header */
                                          /* handlers */
    void          *cmpl_hndlr_addr[A_MAX]; /* Address of */
                                          /* completion handler */
    usrhdr_t      t_uhdr;                 /* Store Header Handler */
                                          /* information */
    void          *uhdr, *udata;
    int           uhdrlen, udatalen;
    int           loop, rc, tgt, val, cur_val;
    char          err_msg_buf[LAPI_MAX_ERR_STRING];

     bzero(&t_info, sizeof(lapi_info_t));
     t_info.err_hndlr = NULL;   /* Not registering error handler */
                                /* function */
```

...main

```
if ((rc = LAPI_Init(&t_hndl, &t_info)) != LAPI_SUCCESS) {
    LAPI_Msg_string(rc, err_msg_buf);
    printf("Error Message: %s, rc = %d\n", err_msg_buf, rc);
    exit (rc);
}

rc = LAPI_Qenv(t_hndl, TASK_ID, &task_id);     /* Get task id */
                                               /* within job */
rc = LAPI_Qenv(t_hndl, NUM_TASKS, &num_tasks); /* Get no. of tasks */
                                               /* in job */

if (num_tasks != 2) {
    printf("Error Message: Program should run on 2 nodes\n");
    exit(1);
}

/* Turn off parameter checking - default is on */
rc = LAPI_Senv(t_hndl, ERROR_CHK, 0);

/* Initialize counters to be zero at the start */
rc = LAPI_Setcntr(t_hndl, &l_cntr, 0);
rc = LAPI_Setcntr(t_hndl, &t_cntr, 0);
rc = LAPI_Setcntr(t_hndl, &c_cntr, 0);

/*
** Exchange buffer address, tgt_cntr address and hdr_hndlr address
** and completion handler address of every task. Collective calls
*/
rc = LAPI_Address_init(t_hndl, t_buf, global_addr);
rc = LAPI_Address_init(t_hndl, &t_cntr, tgt_addr);
rc = LAPI_Address_init(t_hndl, (void *)&hdr_hndlr, hndlr_addr);
rc = LAPI_Address_init(t_hndl, (void *)&do_get, cmpl_hndlr_addr);

if (task_id == 0) { /* Task id is 0 , Origin */
    tgt = task_id + 1;
    for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
        t_buf[loop] = task_id - loop;
    }
    rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                               /* starting */

    /* Fill in uhdr and udata buffers for AM call */
    t_uhdr.cmpl_hndlr  = (compl_hndlr_t *) cmpl_hndlr_addr[1];
    t_uhdr.uinfo       = (int)global_addr[tgt];
    uhdr               = (void *)&t_uhdr;
    uhdrlen            = sizeof(usrhdr_t);
    udata              = (void *) t_buf;
    udatalen           = I_MAX*sizeof(int);

    rc = LAPI_Amsend(t_hndl, tgt, hndlr_addr[tgt], uhdr, uhdrlen,
         (void *) udata, udatalen, tgt_addr[tgt], &l_cntr, &c_cntr);

    /* Wait for local AM completion */
    rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, &cur_val);

    /* Can now change local buffer */
    for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
        t_buf[loop] = loop * task_id;                      ...main

    }

    /* Wait for target AM completion */
    rc = LAPI_Waitcntr(t_hndl, &c_cntr, 1, &cur_val);
    printf("Node %d, done issuing AM to node %d\n", task_id, tgt);
```

```
       rc = LAPI_Gfence(t_hndl);
       rc = LAPI_Get(t_hndl,tgt,I_MAX*sizeof(int), global_addr[tgt],
                                (void *)t_buf, tgt_addr[tgt],&l_cntr);
       /* Wait for local Get completion */
       rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);

       printf("Node %d, done issuing Get from node %d\n", task_id, tgt);
       printf("Result of Get after the Am from node %d: \n", tgt);
       for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
               printf("Val[%d] = %d\n", loop, t_buf[loop]);
       }
    } else { /* Task id is 1 , Target */
       tgt = task_id - 1;
       for (loop=0; loop < I_MAX; loop++) { /* Zero out buffer */
           t_buf[loop] = 0;
       }
       rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                                  /* starting */
       /* Process AM */
       rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
       while (val < 1) {
           sleep(1); /* Do some work */
           rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
           rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
       }
       /* To reset the t_cntr value */
       rc = LAPI_Waitcntr(t_hndl, &t_cntr, 1, &cur_val);
       printf("Node %d, done doing work and processing AM\n", task_id);
       while (!cont) {
           sleep(1); /* Do some work */
       }
       rc = LAPI_Gfence(t_hndl);
       /* Process Get */
       rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
       while (val < 1) {
           sleep(1); /* Do some work */
           rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
           rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
       }
       /* To reset the t_cntr value */
       rc = LAPI_Waitcntr(t_hndl, &t_cntr, 1, &cur_val);
       printf("Node %d, done doing work and processing Get\n", task_id);
   }
   rc = LAPI_Gfence(t_hndl); /* Global fence to sync before */
                             /* terminating job */
   rc = LAPI_Term(t_hndl);
}
```

Active Message (Fortran)

This Fortran program is an example of the use of the LAPI active message call:

```
/* Amf.f */
INCLUDE 'lapif.h'

INTEGER VOLATILE CONT
COMMON /DATA/ CONT
INTEGER T_HNDL, T_INFO(10)
INTEGER TASKID, NUMTASKS
INTEGER T_BUF(10)
INTEGER L_CNTR, T_CNTR, C_CNTR
INTEGER GLOBAL_ADDR(2)
```

```
      INTEGER TGT_ADDR(2), HNDLR_ADDR(2)
      INTEGER LOOP, IERROR, TGT, TGT2, VAL, CUR_VAL, LENGTH
      INTEGER T_ADDR
      INTEGER T_UHDR(2)
      INTEGER UHDR, UDATA
      INTEGER UHDRLEN, UDATALEN
      EXTERNAL DO_GET, HDR_HNDLR

      INTEGER ERR_MSG_BUF(40)

c     Not registering error handler function
      DO I = 1,10
      T_INFO(I) = 0
      ENDDO
      CALL LAPI_ADDRESS(MY_ERR_HNDLR, T_ADDR, IERROR)
      T_INFO(7) = T_ADDR

      CALL LAPI_INIT(T_HNDL, T_INFO, IERROR)
      IF (IERROR .NE. LAPI_SUCCESS) THEN
        VAL = IERROR
        CALL LAPI_MSG_STRING(VAL, ERR_MSG_BUF, IERROR)
        WRITE(6,*)'Error Message ',IERROR
        STOP 1
      ENDIF

c     GET task number and number of tasks in job
      CALL LAPI_QENV(T_HNDL, TASK_ID, TASKID, IERROR)
      CALL LAPI_QENV(T_HNDL, NUM_TASKS, NUMTASKS, IERROR)

      CALL LAPI_QENV(T_HNDL, TIMEOUT, TIME_OUT, IERROR)
      CALL LAPI_QENV(T_HNDL, INTERRUPT_SET, INTR_SET, IERROR)

      IF (TIME_OUT .gt. 30) THEN
        VAL = 15
        CALL LAPI_SENV(T_HNDL, TIMEOUT, VAL, IERROR)
      ENDIF
      IF (INTR_SET .eq. 1) THEN
c       Turn off interrupts
        VAL = 0
        CALL LAPI_SENV(T_HNDL, INTERRUPT_SET, VAL, IERROR)
      ENDIF

c     Turn off parameter checking - default is on
      VAL=0
      CALL LAPI_SENV(T_HNDL, ERROR_CHK, VAL, IERROR)

c     Initialize counters to be zero at the start
      CALL LAPI_SETCNTR(T_HNDL, L_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, C_CNTR, VAL, IERROR)

      WRITE(6,*) "Node ",TASKID," Running AM fortran test."

      IF (NUMTASKS .eq. 2) THEN
c       Run only if number of tasks equal 2
c       Exchange buffer address to every task  -  Collective call
        CALL LAPI_ADDRESS(T_BUF, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,GLOBAL_ADDR,IERROR)
        CALL LAPI_ADDRESS(T_CNTR, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,TGT_ADDR,IERROR)
        CALL LAPI_ADDRESS(HDR_HNDLR, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,HNDLR_ADDR,IERROR)

c       Task id is 0 , Origin
```

```
          IF (TASKID .eq. 0) THEN
            TGT = TASKID + 1

c           Buffer in Fortran start at 1 and not 0
            TGT2 = TGT + 1
            LENGTH = 10*4

            DO LOOP = 1, 10
c             Update buffer
              T_BUF(LOOP) = TASKID - LOOP;
            ENDDO

c           Global FENCE to sync before starting
            CALL LAPI_GFENCE(T_HNDL, IERROR)

c           Fill in uhdr and udata buffers for AM call
            CALL LAPI_ADDRESS(DO_GET, T_UHDR(1), IERROR)
            T_UHDR(2) = GLOBAL_ADDR(TGT2)
            UHDRLEN = 2 * 4

c           Issue AM from origin to target
            CALL LAPI_AMSEND(T_HNDL, TGT, HNDLR_ADDR(TGT2),
     1                       T_UHDR, UHDRLEN, T_BUF, LENGTH,
     2                       TGT_ADDR(TGT2), L_CNTR, C_CNTR, IERROR)

c           CALL LAPI_PUT(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
c    1                    T_BUF, TGT_ADDR(TGT2),
c    2                    L_CNTR, C_CNTR, IERROR)

            VAL = 1
            CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                         LAPI_ADDR_NULL, IERROR)

c           Local buffer can be reused now
            DO LOOP = 1, 10
              T_BUF(LOOP) = TGT2;
            ENDDO

            VAL = 1
            CALL LAPI_WAITCNTR(T_HNDL, C_CNTR, VAL,
     1                         LAPI_ADDR_NULL, IERROR)

            CALL LAPI_GFENCE(T_HNDL, IERROR)
c           Issue GET from origin to target
            CALL LAPI_GET(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
     1                    T_BUF, TGT_ADDR(TGT2),
     2                    L_CNTR, IERROR)
            VAL = 1
            CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                         LAPI_ADDR_NULL, IERROR)

            WRITE(6,*) "Node ",TASKID,
     1                 "done issuing GET from node ", TGT
            WRITE(6,*) "Result of GET from node ", TGT

            DO LOOP = 1, 10
              WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
            ENDDO
c         Task id is 1 , Target
          ELSEIF (TASKID .eq. 1) THEN
            TGT = TASKID - 1
            DO LOOP = 1, 10
c             Zero out buffer
              T_BUF(LOOP) = 0
            ENDDO

            VAL = 0
c         Global FENCE to sync before starting
            CALL LAPI_GFENCE(T_HNDL, IERROR)
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
            DO WHILE (VAL .LT. 1)
c           Can Do some work
              CALL LAPI_PROBE(T_HNDL, IERROR)
              CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
            ENDDO
            WRITE(6,*) "Result of AM from ",TGT, ":"
            DO LOOP = 1, 10
              WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
            ENDDO

            DO WHILE (CONT .NE. 1)
c           Can Do some work
              CALL LAPI_PROBE(T_HNDL, IERROR)
            ENDDO

            CALL LAPI_GFENCE(T_HNDL, IERROR)
c         To clear the T_CNTR VALue
            VAL = 1
            CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
            WRITE(6,*) "Node ", TASKID,
     1               "done doing work and processing AM"
            VAL = 0
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
            DO WHILE (VAL .LT. 1)
c           Can Do some work
              CALL LAPI_PROBE(T_HNDL, IERROR)
              CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
            ENDDO

c         To clear the T_CNTR VALue
            VAL = 1
            CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
            WRITE(6,*) "Node ", TASKID,
     1               "done doing work and processing GET"
          ENDIF

        ENDIF
c     Global FENCE to sync before terminating job
        CALL LAPI_GFENCE(T_HNDL, IERROR)

        CALL LAPI_TERM(T_HNDL, IERROR)
        END



        SUBROUTINE MY_ERR_HNDLR (HNDL, ERROR_CODE, ERR_TYPE,
     1                         TASKID, SRC)

        INCLUDE "lapif.h"
        INTEGER HNDL, ERROR_CODE, ERR_TYPE, TASKID, SRC
        INTEGER BUF(40)

        WRITE(6,*) "In my error handler, HNDL=",HNDL,
     1           " ERROR_CODE=",ERROR_CODE," ERR_TYPE=",ERR_TYPE,
     2           " TASKID=",TASKID," SRC=",SRC
        CALL LAPI_MSG_STRING(ERROR_CODE, BUF, IERROR)
        WRITE(6,*) "In my error handler, error code = ", ERROR_CODE
        IF (ERROR_CODE .ne. LAPI_ERR_TIMEOUT) THEN
c       Cause program to exit
          STOP 2
        ENDIF

        RETURN
        END


        INTEGER FUNCTION HDR_HNDLR(HNDL, UHDR, UHDRLEN, MSGLEN,
     1                           COMPL_HNDLR, SAVED_INFO)
        INCLUDE "lapif.h"
        INTEGER HNDL
        INTEGER UHDR(*)
        INTEGER UHDRLEN
        INTEGER MSGLEN, COMPL_HNDLR, SAVED_INFO
        INTEGER T_ADDR

        WRITE(6,*) "In Header Handler"
        WRITE(6,*) "In Header Handler: UHDRLEN = ", UHDRLEN
        COMPL_HNDLR = UHDR(1)
        SAVED_INFO  = UHDR(2)
        HDR_HNDLR   = UHDR(2)

        RETURN
        END



        SUBROUTINE DO_GET (HNDL, PARAM)

        INCLUDE "lapif.h"
        INTEGER HNDL, PARAM(10)
        INTEGER LOOP
        INTEGER VOLATILE CONT
        COMMON /DATA/ CONT

        WRITE(6,*) "In Completion Handler: Result of AM call"
c     Print Updated buffer
        DO LOOP = 1, 10
            WRITE(6,*) "val[",LOOP,"] = ",PARAM(LOOP)
        ENDDO
        CONT = 1

        RETURN
        END
```

Get (C)

This C program is an example of the use of **LAPI_Get**:

```
/* Get.c
** Example Program illustrating the use of LAPI_Get
*/

#include <lapi.h>

#define A_MAX     2
#define I_MAX     10

int
main(int argc, char **argv)                                             main
{
```

```
lapi_handle_t t_hndl;               /* LAPI context handle - */
                                    /* returned */
lapi_info_t   t_info;               /* LAPI info structure */
int  task_id,                       /* My task id */
              num_tasks;            /* Number of tasks in my job */
int           t_buf[I_MAX];         /* Buffer to manipulate */
lapi_cntr_t   l_cntr;               /* Origin counter */
lapi_cntr_t   t_cntr;               /* Target counter */
void          *global_addr[A_MAX];  /* Array to store t_buf addr */
                                    /* from all the tasks.  The */
                                    /* size of this array needs */
                                    /* to each number of tasks */
void          *tgt_addr[A_MAX];     /* Array to store target */
                                    /* counter addr from all the */
                                    /* tasks. */
int           loop, rc, tgt, val, cur_val;
char          err_msg_buf[LAPI_MAX_ERR_STRING];

bzero(&t_info, sizeof(lapi_info_t));
t_info.err_hndlr = NULL;   /* Not registering error handler /*
                           /* function */
if ((rc = LAPI_Init(&t_hndl, &t_info)) != LAPI_SUCCESS) }
    LAPI_Msg_string(rc, err_msg_buf);
    printf("Error Message: %s, rc = %d\n", err_msg_buf, rc);
    exit (rc);
}
rc = LAPI_Qenv(t_hndl, TASK_ID, &task_id);     /* Get task id */
                                               /* within job */
rc = LAPI_Qenv(t_hndl, NUM_TASKS, &num_tasks); /* Get no. of tasks */
                                               /* in job */

if (num_tasks != 2) }
    printf("Error Message: run with MP_PROCS set to 2\n");
    exit(1);
}

/* Turn off parameter checking - default is on */
rc = LAPI_Senv(t_hndl, ERROR_CHK, 0);

/* Initialize counters to be zero at the start */
rc = LAPI_Setcntr(t_hndl, &l_cntr, 0);
rc = LAPI_Setcntr(t_hndl, &t_cntr, 0);

/* Exchange buffer address and target_counter address of every task */
rc = LAPI_Address_init(t_hndl,t_buf,global_addr);  /* Collective */
                                                   /* call */
                                                                    ...main
rc = LAPI_Address_init(t_hndl,&t_cntr,tgt_addr);   /* Collective */
                                                   /* call */

if (task_id == 0) { /* Task id is 0 , Origin */
    tgt = task_id + 1;
    for (loop=0; loop < I_MAX; loop++) { /* Zero out buffer */
        t_buf[loop] = 0;
    }
    rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                               /* starting */
    rc = LAPI_Get(t_hndl, tgt, I_MAX*sizeof(int), global_addr[tgt],
                            (void *)t_buf, tgt_addr [tgt], &l_cntr);
    rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);

    printf("Node %d, done issuing Get from node %d\n", task_id, tgt) ;
    printf("Result of Get from node %d:\n", tgt);
    for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
```

```
            printf("Val[%d] = %d\n", loop, t_buf[loop]);
        }
    } else { /* Task id is 1 , Target */
        tgt = task_id - 1;
        for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
            t_buf[loop] = loop + task_id;
        }
        rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                                   /* starting */
        rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        while (val != 1) {
            sleep(1); /* Do some work */
            rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
            rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        }
        /* To clear the t_cntr value */
        rc = LAPI_Waitcntr(t_hndl, &t_cntr, val, &cur_val);
        printf("Node %d, done doing work and processing Get\n", task_id) ;
     }
     rc = LAPI_Gfence(t_hndl); /* Global fence to sync before */
                               /* terminating job */
     rc = LAPI_Term(t_hndl);
}
```

Get (Fortran)

This Fortran program is an example of the use of **LAPI_GET**:

```
      /* Getf.f */
      INCLUDE 'lapif.h'

      INTEGER T_HNDL, T_INFO(10)
      INTEGER TASKID, NUMTASKS
      INTEGER T_BUF(10)
      INTEGER L_CNTR, T_CNTR
      INTEGER GLOBAL_ADDR(2)
      INTEGER TGT_ADDR(2)
      INTEGER LOOP, IERROR, TGT, TGT2, VAL, CUR_VAL, LENGTH
      INTEGER T_ADDR1, T_ADDR2, T_ADDR3, T_ADDR4
      INTEGER ERR_MSG_BUF(40)

c     Not registering error handler function
      DO I = 1, 10
      T_INFO(I) = 0
      ENDDO
      CALL LAPI_ADDRESS(LAPI_ADDR_NULL, T_ADDR, IERROR)
      T_INFO(7) = T_ADDR

      CALL LAPI_INIT(T_HNDL, T_INFO, IERROR)
      IF (IERROR .NE. LAPI_SUCCESS) THEN
        VAL = IERROR
        CALL LAPI_MSG_STRING(VAL, ERR_MSG_BUF, IERROR)
        WRITE(6,*)'Error Message ',IERROR
        STOP 1
      ENDIF

c     GET task number and number of tasks in job
      CALL LAPI_QENV(T_HNDL, TASK_ID, TASKID, IERROR)
      CALL LAPI_QENV(T_HNDL, NUM_TASKS, NUMTASKS, IERROR)

c     Turn off parameter checking - default is on
      VAL=0
      CALL LAPI_SENV(T_HNDL, ERROR_CHK, VAL, IERROR)
```

```
c     Initialize counters to be zero at the start
      CALL LAPI_SETCNTR(T_HNDL, L_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, T_CNTR, VAL, IERROR)

      IF (NUMTASKS .eq. 2) THEN
c       Run only if number of tasks equal 2
c       Exchange buffer address to every task  -  Collective call
        CALL LAPI_ADDRESS(T_BUF, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,GLOBAL_ADDR,IERROR)
        CALL LAPI_ADDRESS(T_CNTR, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,TGT_ADDR,IERROR)

c       Task id is 0 , Origin
        IF (TASKID .eq. 0) THEN
          TGT = TASKID + 1

c         Buffer in Fortran start at 1 and not 0
          TGT2 = TGT + 1
          LENGTH = 10*4

          DO LOOP = 1, 10
c           Zero out buffer
            T_BUF(LOOP) = 0;
          ENDDO


c         Global FENCE to sync before starting
          CALL LAPI_GFENCE(T_HNDL, IERROR)

c         Issue GET from origin to target
          CALL LAPI_GET(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
     1                 T_BUF, TGT_ADDR(TGT2),
     2                 L_CNTR, IERROR)
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                      LAPI_ADDR_NULL, IERROR)

          WRITE(6,*) "Node ",TASKID,
     1              "done issuing GET from node ", TGT
          WRITE(6,*) "Result of GET from node ", TGT

          DO LOOP = 1, 10
            WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
          ENDDO
c       Task id is 1 , Target
        ELSEIF (TASKID .eq. 1) THEN
          TGT = TASKID - 1
          DO LOOP = 1, 10
c           Update buffer
            T_BUF(LOOP) = LOOP + TASKID
            WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
          ENDDO

          VAL = 0
c         Global FENCE to sync before starting
          CALL LAPI_GFENCE(T_HNDL, IERROR)
          CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          DO WHILE (VAL .LT. 1)
c           Can Do some work
            CALL LAPI_PROBE(T_HNDL, IERROR)
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          ENDDO
```

```
c         To clear the T_CNTR VALue
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
          WRITE(6,*) "Node ", TASKID,
     1               "done doing work and processing Put"
        ENDIF

      ENDIF
c     Global FENCE to sync before terminating job
      CALL LAPI_GFENCE(T_HNDL, IERROR)

      CALL LAPI_TERM(T_HNDL, IERROR)
      END
```

Put (C)

This C program is an example of the use of **LAPI_Put** and **LAPI_Get**:

```
/* Put.c
** Example program illustrating the use of LAPI_Put and LAPI_Get
*/

#include <lapi.h>

#define A_MAX     2
#define I_MAX     10

int
main(int argc, char **argv)                                              main
{
    lapi_handle_t t_hndl;              /* LAPI context handle - */
                                       /* returned */
    lapi_info_t   t_info;              /* LAPI info structure */
    int           task_id,             /* My task id */
                  num_tasks;           /* Number of tasks in my job */
    int           t_buf[I_MAX];        /* Buffer to manipulate */
    lapi_cntr_t   l_cntr;              /* Origin counter */
    lapi_cntr_t   t_cntr;              /* Target counter */
    lapi_cntr_t   c_cntr;              /* Completion counter */
    void          *global_addr[A_MAX]; /* Array to store t_buf */
                                       /* addr from all the tasks */
                                       /* The size of this array */
                                       /* needs to each number of tasks */
    void          *tgt_addr[A_MAX];    /* Array to store target */
                                       /* counter ad from all the */
                                       /* tasks. */
    int           loop, rc, tgt, val, cur_val;
    char          err_msg_buf[LAPI_MAX_ERR_STRING];

    bzero(&t_info, sizeof(lapi_info_t));
    t_info.err_hndlr = NULL;   /* Not registering error handler function */
    if ((rc = LAPI_Init(&t_hndl, &t_info)) != LAPI_SUCCESS) {
        LAPI_Msg_string(rc, err_msg_buf);
        printf("Error Message: %s, rc = %d\n", err_msg_buf, rc);
        exit (rc);
    }
    rc = LAPI_Qenv(t_hndl, TASK_ID, &task_id);     /* Get task number */
                                                   /* within job */
    rc = LAPI_Qenv(t_hndl, NUM_TASKS, &num_tasks); /* Get number of */
                                                   /* tasks in job */

    if (num_tasks != 2) }
        printf("Error Message: Run with MP_PROCS set to 2\n");
        exit(1);
    }

    /* Turn off parameter checking - default is on */
    rc = LAPI_Senv(t_hndl, ERROR_CHK, 0);

    /* Initialize counters to be zero at the start */
    rc = LAPI_Setcntr(t_hndl, &l_cntr, 0);
    rc = LAPI_Setcntr(t_hndl, &t_cntr, 0);
    rc = LAPI_Setcntr(t_hndl, &c_cntr, 0);

    /* Exchange buffer address and target counter address of every task */
    rc = LAPI_Address_init(t_hndl,t_buf,global_addr);    /* Collective call */
    rc = LAPI_Address_init(t_hndl,&t_cntr,tgt_addr);     /* Collective call */

    if (task_id == 0) { /* Task id is 0 , Origin */
        tgt = task_id + 1;
        for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
            t_buf[loop] = task_id - loop;
        }
        rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before starting */
        rc = LAPI_Put(t_hndl,tgt,I_MAX*sizeof(int), global_addr[tgt],
                      (void *)t_buf,tgt_addr[tgt],,&l_cntr,&c_cntr);
        /* Wait for local Put completion */
        rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);

        /* Can now change local buffer */
        for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
            t_buf[loop] = loop * task_id;
        }

        /* Wait for target Put completion at task 1 as well */
        rc = LAPI_Waitcntr(t_hndl, &c_cntr, 1, NULL);
        printf("Node %d, done issuing Put to node %d\n", task_id, tgt);

        rc = LAPI_Get(t_hndl,tgt,I_MAX*sizeof(int), global_addr[tgt],
                                   (void *)t_buf,tgt_addr[tgt],&l_cntr);
        /* Wait for local Get completion */
        rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);
        printf("Node %d, done issuing Get from node %d\n", task_id, tgt);
        printf("Result of Get after the Put from node %d:\n", tgt);
        for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
            printf("Val[%d] = %d\n", loop, t_buf[loop]);
        }
    } else { /* Task id is 1 , Target */
        tgt = task_id - 1;
        for (loop=0; loop < I_MAX; loop++) { /* Zero out buffer */
            t_buf[loop] = 0;
        }
        rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before starting */
        /* Process Put */
        rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        while (val < 1) {
            sleep(1); /* Do some work */
            rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
            rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        }
        /* To clear the t_cntr value */
        rc = LAPI_Waitcntr(t_hndl, &t_cntr, 1, &cur_val);
        printf("Node %d, done doing work and processing Put\n", task_id);
        printf("Result of Put from %d:\n", tgt);
        for (loop=0; loop < I_MAX; loop++) { /* Update buffer */
            printf("Val[%d] = %d\n", loop, t_buf[loop]);
        }
        /* Process Get */
        rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        while (val < 1) {
            sleep(1); /* Do some work */
            rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
            rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        }

        /* To clear the t_cntr value */
        rc = LAPI_Waitcntr(t_hndl, &t_cntr, 1, &cur_val);
        printf("Node %d, done doing work and processing Get\n", task_id);
    }
    rc = LAPI_Gfence(t_hndl); /* Global fence to sync before terminating job */
    rc = LAPI_Term(t_hndl);
}
```

Put (Fortran)

This Fortran program is an example of the use of **LAPI_PUT** and **LAPI_GET**:

```
      /* Putf.f */
      INCLUDE 'lapif.h'

      INTEGER T_HNDL, T_INFO(10)
      INTEGER TASKID, NUMTASKS
      INTEGER T_BUF(10)
      INTEGER L_CNTR, T_CNTR, C_CNTR
      INTEGER GLOBAL_ADDR(2)
      INTEGER TGT_ADDR(2)
      INTEGER LOOP, IERROR, TGT, TGT2, VAL, CUR_VAL, LENGTH
      INTEGER T_ADDR
      INTEGER ERR_MSG_BUF(40)

c     Not registering error handler function
      CALL LAPI_ADDRESS(LAPI_ADDR_NULL, T_ADDR, IERROR)
      T_INFO(7) = T_ADDR

      CALL LAPI_INIT(T_HNDL, T_INFO, IERROR)
      IF (IERROR .NE. LAPI_SUCCESS) THEN
        VAL = IERROR
        CALL LAPI_MSG_STRING(VAL, ERR_MSG_BUF, IERROR)
        WRITE(6,*)'Error Message ',IERROR
        STOP 1
      ENDIF

c     GET task number and number of tasks in job
      CALL LAPI_QENV(T_HNDL, TASK_ID, TASKID, IERROR)
      CALL LAPI_QENV(T_HNDL, NUM_TASKS, NUMTASKS, IERROR)

c     Turn off parameter checking - default is on
      VAL=0
      CALL LAPI_SENV(T_HNDL, ERROR_CHK, VAL, IERROR)

c     Initialize counters to be zero at the start
      CALL LAPI_SETCNTR(T_HNDL, L_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, C_CNTR, VAL, IERROR)

      IF (NUMTASKS .eq. 2) THEN
c       Run only if number of tasks equal 2
c       Exchange buffer address to every task  -  Collective call
        CALL LAPI_ADDRESS(T_BUF, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,GLOBAL_ADDR,IERROR)
        CALL LAPI_ADDRESS(T_CNTR, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,TGT_ADDR,IERROR)

c     Task id is 0 , Origin
        IF (TASKID .eq. 0) THEN
          TGT = TASKID + 1

c       Buffer in Fortran start at 1 and not 0
          TGT2 = TGT + 1
          LENGTH = 10*4

          DO LOOP = 1, 10
c         Update buffer
            T_BUF(LOOP) = TASKID - LOOP;
          ENDDO

c       Global FENCE to sync before starting
          CALL LAPI_GFENCE(T_HNDL, IERROR)

c       Issue PUT from origin to target
          CALL LAPI_PUT(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
     1                T_BUF, TGT_ADDR(TGT2),
     2                L_CNTR, C_CNTR, IERROR)
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                     LAPI_ADDR_NULL, IERROR)

c       Local buffer can be reused now
          DO LOOP = 1, 10
            T_BUF(LOOP) = TGT2;
          ENDDO


          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, C_CNTR, VAL,
     1                     LAPI_ADDR_NULL, IERROR)

c       Issue GET from origin to target
          CALL LAPI_GET(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
     1                T_BUF, TGT_ADDR(TGT2),
     2                L_CNTR, IERROR)
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                     LAPI_ADDR_NULL, IERROR)

          WRITE(6,*) "Node ",TASKID,
     1             "done issuing GET from node ", TGT
          WRITE(6,*) "Result of GET from node ", TGT

          DO LOOP = 1, 10
            WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
          ENDDO
c     Task id is 1 , Target
        ELSEIF (TASKID .eq. 1) THEN
          TGT = TASKID - 1
          DO LOOP = 1, 10
c         Zero out buffer
            T_BUF(LOOP) = 0
          ENDDO

          VAL = 0
c       Global FENCE to sync before starting
          CALL LAPI_GFENCE(T_HNDL, IERROR)
          CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
```

```
          DO WHILE (VAL .LT. 1)
c           Can Do some work
            CALL LAPI_PROBE(T_HNDL, IERROR)
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          ENDDO
          WRITE(6,*) "Result of Put from ",TGT, ":"
          DO LOOP = 1, 10
            WRITE(6,*) "T_BUF(",LOOP,") = ", T_BUF(LOOP)
          ENDDO

c         To clear the T_CNTR VALue
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
          WRITE(6,*) "Node ", TASKID,
     1               "done doing work and processing PUT"
          VAL = 0
          CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          DO WHILE (VAL .LT. 1)
c           Can Do some work
            CALL LAPI_PROBE(T_HNDL, IERROR)
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          ENDDO

c         To clear the T_CNTR VALue
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
          WRITE(6,*) "Node ", TASKID,
     1               "done doing work and processing GET"
        ENDIF

      ENDIF
c     Global FENCE to sync before terminating job
      CALL LAPI_GFENCE(T_HNDL, IERROR)

      CALL LAPI_TERM(T_HNDL, IERROR)
      END
```

putv_multi_gen (C)

This C program is an example of transferring noncontiguous data using the LAPI vector transfer function:

```
/* putv_multi_gen.c
** Example Program showing use of the LAPI vector transfer function.
*/

#include <stdio.h>
#include <assert.h>
#include "lapi.h"

#define MAX_TASKS            4           /* Max tasks in the parallel job */
#define MAX_GLOBAL_ADDR     16           /* Max size of local address table */
#define ARR_SZ         8280000           /* Size of array */
#define NUM_ITER            10           /* Max number of iterations */
#define NUM_TIMES            4

extern double microsecond();            /* defined in the timer library */

int sizes[] = {3,4,9, 16, 30, 64, 128, 171, 256, 353,1000};
lapi_handle_t     hndl;                         /* Handle to the lapi context */
lapi_info_t       info_lapi;                    /* to be passed to LAPI_Init */

int   myid, numtasks;                    /* taskid and numtasks in || job */
```

```
#define ROWS               353
#define COLUMNS           3000

char        g1[ROWS][COLUMNS];           /* Array which w   */

lapi_vec_t  org_vec,tgt_vec;

void        *g1_addr[MAX_TASKS];         /* Address of g1 of other tasks */
lapi_vec_t  *vec_addr[MAX_TASKS];        /* Address of g1 of other tasks */
void        *global_addr[MAX_TASKS];     /* Address of global_address tables
                                         ** of each task
                                         */
void        *local_addr[MAX_GLOBAL_ADDR]; /* Address of local address table */
lapi_cntr_t c1, c2, c3;                  /* LAPI counters */
lapi_cntr_t *c1_addr[MAX_TASKS], *c2_addr[MAX_TASKS], *c3_addr[MAX_TASKS];
                                         /* Address of counters on each task */
double results[NUM_TIMES];

/*
** Macros to turn interrupts on and off, and to turn error checking off
*/
#define INTR_ON       LAPI_Senv(hndl, INTERRUPT_SET, 1) /* Turn interrupts on*/
#define INTR_OFF      LAPI_Senv(hndl, INTERRUPT_SET, 0) /* Turn inter off */
#define INTR_CNT(num) LAPI_Qenv(hndl, 22, &(num))
#define INTR_CNT_OFF  LAPI_Senv(hndl, 22, 0)
#define ERR_CHK_OFF   LAPI_Senv(hndl, ERROR_CHK, 0)   /* Turn error checking off*/

/*
** Function: This measures Putv bandwidth for a given message size by sending
**           a message from task 0 to task 1 and returning the message
**           from task 1 to task 0.
*/
void
rr_one_way_lat(int cnt)
{
    double t0, t1, t1_pr, t1_dpr, diff;
    int i, rc, tmp_cntr = 0;

    diff = 0.0;

    t0 = microsecond();
    for (i=0;i<NUM_ITER; i++) {
        if (myid == 0)    {
            //g1[1] = 1024;
            rc=LAPI_Putv(hndl, 1, &tgt_vec, &org_vec, c1_addr[1], NULL, NULL);
            LAPI_Waitcntr(hndl, &c1, 1, NULL);
        } else if (myid == 1) {
         LAPI_Waitcntr(hndl, &c1, 1, NULL);
         rc=LAPI_Putv(hndl, 0, &tgt_vec, &org_vec, c1_addr[0], NULL, NULL);
        }
    }
    t1 = microsecond();

    if (myid == 0) {
        results[0] = (t1 - t0)/(2.0 * NUM_ITER);
        results[0] = (cnt*cnt*8)/(results[0]);
    }
}

/*
** Function: This runs the rr_one_way_lat function for various message sizes
**           and prints the results.
*/
```

```
void
run_tests(int i)
{
    int rc, cnt;

    INTR_OFF;

    for (cnt=0; cnt < 1; cnt++)  {
        rr_one_way_lat(i);
    }
    if (myid == 0)
        for(cnt=0; cnt < 1; cnt++)
            printf("Putv bandwidth (gen) for %d X %d array = %lf\n", i,i,results[cnt]);
}

/*
** Main function.
** Sets up the LAPI environment, initialized variables, counters, and addresses
** and calls run_tests.
*/

main()
{
    int  i,j,k,rc, cntr, partner;
    uint addr_ptr;

    /* Initialize global data structures to 0 */
    init_stamp(NULL, NULL);
    bzero(g1, sizeof(g1));
    bzero(local_addr, sizeof(local_addr));
    bzero(global_addr, sizeof(global_addr));
    bzero(&info_lapi, sizeof(lapi_info_t));

    rc = LAPI_Init(&hndl, &info_lapi);    /* Initialize the LAPI library */
    assert(rc == 0);


    /* Query LAPI library for taskid and number of tasks in job  */
    rc = LAPI_Qenv(hndl, TASK_ID, &myid);
    rc = LAPI_Qenv(hndl, NUM_TASKS, &numtasks);
    LAPI_Senv(hndl, ERROR_CHK,0);
    if (myid == 0) partner = 1; else partner = 0;

    /* Initialize LAPI counters */
    rc = LAPI_Setcntr(hndl, &c1, 0);
    rc = LAPI_Setcntr(hndl, &c2, 0);
    rc = LAPI_Setcntr(hndl, &c3, 0);


    /* Fill in local address table */
    rc = LAPI_Address(g1, (uint *)&local_addr[0]);

    /* Exchange local address table with every task */
    rc = LAPI_Address_init(hndl, local_addr, global_addr);

    /* Exchange other address of importance to LAPI like g1, and counters */
    rc = LAPI_Address_init(hndl, (void *)g1, g1_addr);

    rc = LAPI_Address_init(hndl, (void *)&org_vec, (void *)vec_addr);
    rc = LAPI_Address_init(hndl, (void *)&c1, (void *)c1_addr);
    rc = LAPI_Address_init(hndl, (void *)&c2, (void *)c2_addr);
    rc = LAPI_Address_init(hndl, (void *)&c3, (void *)c3_addr);
    // ERR_CHK_OFF;
    rc = LAPI_Gfence(hndl);

    for (k=0; k < 11; k++) {
         i = sizes[k];

         org_vec.vec_type = LAPI_GEN_IOVECTOR;
         org_vec.num_vecs  = i;
         org_vec.info = (void **) malloc(i * sizeof(void *));
         for (j=0;j<i;j++)
              org_vec.info[j] = (void *) g1[j];
         org_vec.len =  (uint *) malloc(i * sizeof(uint));
         for (j=0;j<i;j++)
            org_vec.len[j] =  i*8;

        tgt_vec.vec_type = LAPI_GEN_IOVECTOR;
        tgt_vec.num_vecs  = i;
        tgt_vec.info = (void **) malloc(i * sizeof(void *));

        for (j=0;j<i;j++)
             tgt_vec.info[j] = (void *) (g1_addr[partner] +j*COLUMNS);
        tgt_vec.len =  (uint *) malloc(i * sizeof(uint));
        for (j=0;j<i;j++)
            tgt_vec.len[j] =  i*8;

        run_tests(i);                               /* Run various LAPI tests */

        rc = LAPI_Gfence(hndl);
        free(org_vec.info);
        free(tgt_vec.info);
  }

    rc = LAPI_Term(hndl);
}
```

putv.f (Fortran)

This Fortran program is an example of transferring noncontiguous data using the LAPI vector transfer function:

```
/* lapi_fbinding_1 */
/* Example Program showing use of the LAPI vector transfer function. */

        implicit none
        include 'lapif.h'
        integer i
        integer eh_addr, hndl
        integer ierr, val, value
        integer ocntr,tcntr,ccntr,curcntrval
        integer addr_oc, addr_tc, addr_cc
        integer org_vec(4)
        integer tgt_vec(4)
        integer tgt_vec_addr
        integer tgt_vec_array(0:1023)
        integer recv_buf(1000000)
        integer send_buf(1000000)
        integer blk_size, stride, num_vecs
        integer tgt
        integer tgt_info_array(1024)
        integer org_info_array(1024)
        integer info(10)
        integer error_handler
        integer taskid,numtasks,maxuhdrsz,maxdatasz,maxpktsz
        character err_msg_buf(160)
```

```
      call LAPI_Init(hndl, info, ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Init Error message: ',err_msg_buf
       STOP 1
      else
       write(6,*) 'LAPI_Init SUCCESSFUL     '
      endif

      call LAPI_Address(tgt_vec, tgt_vec_addr , ierr)
      call LAPI_Address_init(hndl, tgt_vec_addr, tgt_vec_array, ierr)

      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Address_init Error message: ',err_msg_buf
       STOP 1
      else
       write(6,*) 'LAPI_Address_init SUCCESSFUL     '
      endif

      call LAPI_Qenv(hndl,TASK_ID,taskid,ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Qenv Error message: ',err_msg_buf
       STOP 1
      endif
      call LAPI_Qenv(hndl,NUM_TASKS,numtasks,ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Qenv Error message: ',err_msg_buf
       STOP 1
      endif
      call LAPI_Qenv(hndl,MAX_UHDR_SZ,maxuhdrsz,ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Qenv Error message: ',err_msg_buf
       STOP 1
      endif
      call LAPI_Qenv(hndl,MAX_DATA_SZ,maxdatasz,ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Qenv Error message: ',err_msg_buf
       STOP 1
      endif
      call LAPI_Qenv(hndl,MAX_PKT_SZ,maxpktsz,ierr)
      if (ierr .ne. LAPI_SUCCESS) then
       val = ierr
       call LAPI_Msg_string(val,err_msg_buf,ierr)
       write(6,*) 'LAPI_Qenv Error message: ',err_msg_buf
       STOP 1
      endif
      write(6,*) 'numtasks = ',numtasks,' taskid = ',taskid,
     x    ' max_pkt_sz = ',maxpktsz,' max_uhdr_sz = ',maxuhdrsz,
     x    ' max_data_sz = ',maxdatasz
      blk_size = 1024
      num_vecs = 4
      stride   = 2000
```

```
        org_vec(1) = LAPI_GEN_STRIDED_XFER
        tgt_vec(1) = LAPI_GEN_STRIDED_XFER
        org_vec(2) = num_vecs
        tgt_vec(2) = num_vecs
        call LAPI_Address(org_info_array, org_vec(3), ierr)
        call LAPI_Address(tgt_info_array, tgt_vec(3), ierr)
        call LAPI_Address(send_buf, org_info_array(1), ierr)
        call LAPI_Address(recv_buf, tgt_info_array(1), ierr)
        org_info_array(2) = blk_size
        tgt_info_array(2) = blk_size
        org_info_array(3) = stride
        tgt_info_array(3) = stride
C
        tgt = mod((taskid + 1),numtasks)


        call LAPI_Gfence(hndl,ierr)
        write(6,*) 'After 1st Gfence...'

        write(6,*) "Issuing Putv..."
        call LAPI_Putv(hndl,tgt,tgt_vec_array(tgt),org_vec,
     x       LAPI_ADDR_NULL,LAPI_ADDR_NULL,LAPI_ADDR_NULL,ierr)

        write(6,*) "Done issuing Putv..."

        if (ierr .ne. LAPI_SUCCESS) then
         val = ierr
         call LAPI_Msg_string(val,err_msg_buf,ierr)
         write(6,*) 'LAPI_Putv Error message: ',err_msg_buf
        else
         write(6,*) 'LAPI_Putv SUCCESSFUL.....'
        endif

        write(6,*) 'Issuing LAPI_Gfence........'
        call LAPI_Gfence(hndl,ierr)
        write(6,*) 'Done issuing LAPI_Gfence........'
c
        write(6,*) 'Issuing LAPI_Term........'
        call LAPI_Term(hndl, ierr)
        write(6,*) 'Done issuing LAPI_Term........'
        if (ierr .ne. LAPI_SUCCESS) then
         val = ierr
         call LAPI_Msg_string(val,err_msg_buf,ierr)
         write(6,*) 'LAPI_Term Error message: ',err_msg_buf
         STOP 1
        else
         write(6,*) 'LAPI_Term SUCCESSFUL     '
        endif
c
        end
c
        subroutine error_handler(hndl,error_code,err_type,taskid,src)
        include "lapif.h"
        integer buf(40), ierr, error_code
        character carray(160)
        write(6,*) 'Error Handler: CODE = ',error_code,'error type = ',
     x   err_type,'taskid = ',taskid,' src = ',src
        call LAPI_Msg_string(error_code, carray, ierr)
        write(6,*) "Error message = ",carray
        return
        end
```

Rmw (C)

This C program is an example of **LAPI_Rmw** (read/modify/write function):

```
/* Rmw.c
** Example Program showing use of read modify write function (LAPI_Rmw).
*/

#include <lapi.h>
#include <signal.h>
#include <unistd.h>

#define A_MAX     2

/*
** User error handler function.
*/

void my_err_hndlr (lapi_handle_t *hndl, int *error_code,
                   lapi_err_t *err_type, int *task_id, int *src)
{
    char buf[LAPI_MAX_ERR_STRING];

    printf("In my error handler, hndl=%d, error_code=%d, err_type=%d, "
           "task_id=%d, src=%d\n", *hndl,*error_code,*err_type,*task_id,*src);
    LAPI_Msg_string(*error_code,buf);
    printf("In my error handler, error code = %d, error reason = %s\n",
           *error_code, buf);
    if (*error_code != LAPI_ERR_TIMEOUT)
        kill(getpid(),SIGTERM);  /* Cause program to exit */
}

int
main(int argc, char **argv)                                               main
{
    lapi_handle_t t_hndl;              /* LAPI context handle - returned */
    lapi_info_t   t_info;              /* LAPI info structure */
    int           task_id,             /* My task id */
                  num_tasks;           /* Number of tasks in my job */
    int           t_buf;               /* Buffer to manipulate */
    int           t2_buf;              /* Temporary Buffer */
    lapi_cntr_t   l_cntr;              /* Origin counter */
    lapi_cntr_t   t_cntr;              /* Target counter */
    void          *global_addr[A_MAX]; /* Array to store t_buf addr from */
                                       /* all the tasks.  The size of */
                                       /* this array needs to each */
                                       /* number of tasks */
    void          *tgt_addr[A_MAX];    /* Array to store target counter */
                                       /* addr from all the tasks. */
    int           loop, rc, tgt, val, cur_val, prev_tgt_val;
    char          err_msg_buf[LAPI_MAX_ERR_STRING];
    int           time_out;            /* Get current timeout value */
    int           intr_set;            /* Get current interrupt setting */

   bzero(&info_lapi, sizeof(lapi_info_t));
   t_info.err_hndlr = my_err_hndlr;    /* register an error handler */
                                       /* function */

    if ((rc = LAPI_Init(&t_hndl, &t_info)) != LAPI_SUCCESS) {
        LAPI_Msg_string(rc, err_msg_buf);
        printf("Error Message: %s, rc = %d\n", err_msg_buf, rc);
        exit (rc);
    }
```

```
rc = LAPI_Qenv(t_hndl, TASK_ID, &task_id);
rc = LAPI_Qenv(t_hndl, NUM_TASKS, &num_tasks);

if (num_tasks != 2) {
    printf("Error Message: Run with MP_PROCS set to 2\n");
    LAPI_Term (t_hndl);
    exit(1);
}

rc = LAPI_Qenv(t_hndl, TIMEOUT, &time_out);  /* Value in seconds */
rc = LAPI_Qenv(t_hndl, INTERRUPT_SET, &intr_set);

if (time_out > 30) {
    rc = LAPI_Senv(t_hndl, TIMEOUT, 15);  /* Should be > */
                                          /* MIN_TIMEOUT */
}
if (intr_set == 1) {
    rc = LAPI_Senv(t_hndl, INTERRUPT_SET, 0);  /* Turn off */
                                               /* interrupts */
}
/* Turn off parameter checking - default is on */
rc = LAPI_Senv(t_hndl, ERROR_CHK, 0);

/* Initialize counters to be zero at the start */
rc = LAPI_Setcntr(t_hndl, &l_cntr, 0);
rc = LAPI_Setcntr(t_hndl, &t_cntr, 0);

/* Exchange buffer address to every task */
rc = LAPI_Address_init(t_hndl, &t_buf, global_addr);       /* Collective */
                                                           /* call */
rc = LAPI_Address_init(t_hndl, &t_cntr, tgt_addr);         /* Collective */
                                                           /* call */

if (task_id == 0) { /* Task id is 0 , Origin */
    tgt = task_id + 1;
    t_buf = 1;  /* Initial value to add at target */

    rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                               /* starting */
    rc = LAPI_Rmw(t_hndl, FETCH_AND_ADD, tgt, global_addr[tgt],
                                &t_buf, &prev_tgt_val, &l_cntr);
    /* Wait for local Rmw completion */
    rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);

    printf("Node %d, done issuing Rmw to node %d\n", task_id, tgt);

    rc = LAPI_Get(t_hndl,tgt,sizeof(int),global_addr [tgt],
                    (void *)&t2_buf,tgt_addr [tgt],&l_cntr);
    /* Wait for local Get completion */
    rc = LAPI_Waitcntr(t_hndl, &l_cntr, 1, NULL);
    printf("Node %d, done issuing Get from node %d\n", task_id, tgt);
    printf("Result of Get after the Rmw from node %d:\n", tgt);
    printf("Correct value should be %d = %d\n",
                                t_buf + prev_tgt_val, t2_buf);
} else { /* Task id is 1 , Target */
    tgt = task_id - 1;
                                                                   ...main
    t_buf = 5; /* Set initial buffer value */
    rc = LAPI_Gfence(t_hndl);  /* Global fence to sync before */
                               /* starting */
    /* Process Get */
    rc=LAPI_Getcntr(t_hndl, &t_cntr, &val);
    while (val < 1) {
        sleep(1); /* Do some work */
```

```
            rc = LAPI_Probe(t_hndl); /* Poll the adapter once */
            rc = LAPI_Getcntr(t_hndl, &t_cntr, &val);
        }
        /* To clear the t_cntr value */
        rc = LAPI_Waitcntr(t_hndl, &t_cntr, 1, &cur_val);
        printf("Node %d, done doing work and processing Get\n", task_id);
    }
    rc = LAPI_Gfence(t_hndl); /* Global fence to sync before */
                              /* terminating job */
    rc = LAPI_Term(t_hndl);
}
```

Rmw (Fortran)

This Fortran program is an example of **LAPI_RMW** (read/write/modify function):

```
      /* Rmwf.f */
      INCLUDE 'lapif.h'

      INTEGER T_HNDL, T_INFO(10)
      INTEGER TASKID, NUMTASKS
      INTEGER T_BUF, T2_BUF, PREV_TGT_VAL
      INTEGER L_CNTR, T_CNTR
      INTEGER GLOBAL_ADDR(2)
      INTEGER TGT_ADDR(2)
      INTEGER LOOP, IERROR, TGT, TGT2, VAL, CUR_VAL, LENGTH
      INTEGER T_ADDR, TIME_OUT, INTR_SET
      INTEGER ERR_MSG_BUF(40)

c     Not registering error handler function
      DO I = 1, 10
      T_INFO(I) = 0
      ENDDO
      CALL LAPI_ADDRESS(MY_ERR_HNDLR, T_ADDR, IERROR)
      T_INFO(7) = T_ADDR

      CALL LAPI_INIT(T_HNDL, T_INFO, IERROR)
      IF (IERROR .NE. LAPI_SUCCESS) THEN
        VAL = IERROR
        CALL LAPI_MSG_STRING(VAL, ERR_MSG_BUF, IERROR)
        WRITE(6,*)'Error Message ',IERROR
        STOP 1
      ENDIF

c     GET task number and number of tasks in job
      CALL LAPI_QENV(T_HNDL, TASK_ID, TASKID, IERROR)
      CALL LAPI_QENV(T_HNDL, NUM_TASKS, NUMTASKS, IERROR)

      CALL LAPI_QENV(T_HNDL, TIMEOUT, TIME_OUT, IERROR)
      CALL LAPI_QENV(T_HNDL, INTERRUPT_SET, INTR_SET, IERROR)

      IF (TIME_OUT .gt. 30) THEN
        VAL = 15
        CALL LAPI_SENV(T_HNDL, TIMEOUT, VAL, IERROR)
      ENDIF
      IF (INTR_SET .eq. 1) THEN
c       Turn off interrupts
        VAL = 0
        CALL LAPI_SENV(T_HNDL, INTERRUPT_SET, VAL, IERROR)
      ENDIF

c     Turn off parameter checking - default is on
      VAL=0
      CALL LAPI_SENV(T_HNDL, ERROR_CHK, VAL, IERROR)

c     Initialize counters to be zero at the start
      CALL LAPI_SETCNTR(T_HNDL, L_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
      CALL LAPI_SETCNTR(T_HNDL, C_CNTR, VAL, IERROR)

      IF (NUMTASKS .eq. 2) THEN
c       Run only if number of tasks equal 2
c       Exchange buffer address to every task  -  Collective call
        CALL LAPI_ADDRESS(T_BUF, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,GLOBAL_ADDR,IERROR)
        CALL LAPI_ADDRESS(T_CNTR, T_ADDR, IERROR)
        CALL LAPI_ADDRESS_INIT(T_HNDL,T_ADDR,TGT_ADDR,IERROR)

c       Task id is 0 , Origin
        IF (TASKID .eq. 0) THEN
          TGT = TASKID + 1

c         Buffer in Fortran start at 1 and not 0
          TGT2 = TGT + 1
c         Get INTEGER size buffer
          LENGTH = 4

c         Initial value to add at target
          T_BUF = 1

c         Global FENCE to sync before starting
          CALL LAPI_GFENCE(T_HNDL, IERROR)

c         Issue RMW from origin to target
          CALL LAPI_RMW(T_HNDL, FETCH_AND_ADD, TGT,
     1                 GLOBAL_ADDR(TGT2), T_BUF,
     2                 PREV_TGT_VAL, L_CNTR, IERROR)
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                      CUR_VAL, IERROR)
          WRITE(6,*) "Node ",TASKID,
     1              "done issuing RMW from node ", TGT

c         Issue GET from origin to target
          CALL LAPI_GET(T_HNDL,TGT,LENGTH,GLOBAL_ADDR(TGT2),
     1                 T2_BUF, TGT_ADDR(TGT2),
     2                 L_CNTR, IERROR)
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, L_CNTR, VAL,
     1                      LAPI_ADDR_NULL, IERROR)

          WRITE(6,*) "Node ",TASKID,
     1              "done issuing GET from node ", TGT
          WRITE(6,*) "Result of GET from node ", TGT

          VAL = T_BUF + PREV_TGT_VAL
          WRITE(6,*) "Correct value should be ",VAL,
     1              " = ", T2_BUF

c       Task id is 1 , Target
        ELSEIF (TASKID .eq. 1) THEN
          TGT = TASKID - 1
c         Set initial buffer value
          T_BUF = 5

          VAL = 0
c         Global FENCE to sync before starting
```

```
          CALL LAPI_GFENCE(T_HNDL, IERROR)
          CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          DO WHILE (VAL .LT. 1)
c           Can Do some work
            CALL LAPI_PROBE(T_HNDL, IERROR)
            CALL LAPI_GETCNTR(T_HNDL, T_CNTR, VAL, IERROR)
          ENDDO


c         To clear the T_CNTR VALue
          VAL = 1
          CALL LAPI_WAITCNTR(T_HNDL, T_CNTR, VAL, CUR_VAL, IERROR)
          WRITE(6,*) "Node ", TASKID,
     1                "done doing work and processing GET"
        ENDIF

      ENDIF
c     Global FENCE to sync before terminating job
      CALL LAPI_GFENCE(T_HNDL, IERROR)

      CALL LAPI_TERM(T_HNDL, IERROR)
      END


      SUBROUTINE MY_ERR_HNDLR (HNDL, ERROR_CODE, ERR_TYPE,
     1                         TASKID, SRC)

      INCLUDE "lapif.h"
      INTEGER BUF(40)

      WRITE(6,*) "In my error handler, HNDL=",HNDL,
     1           " ERROR_CODE=",ERROR_CODE," ERR_TYPE=",ERR_TYPE,
     2           " TASKID=",TASKID," SRC=",SRC
      CALL LAPI_MSG_STRING(ERROR_CODE, BUF, IERROR)
      WRITE(6,*) "In my error handler, error code = ", ERROR_CODE
      IF (ERROR_CODE .ne. LAPI_ERR_TIMEOUT) THEN
c       Cause program to exit
        STOP 2
      ENDIF

      RETURN
      END
```

Appendixes

Appendix A. Managing Root Volume Groups

This is a discussion of the SP system implementation of root volume group mirroring and of using alternate root volume groups. It gives a brief description of common terminology and mirroring support in AIX. It does not provide a complete description of AIX mirroring or volume group support. For that information, reference the appropriate AIX publications.

You can mirror root volume groups so that you have a backup or two of the same version of AIX always ready and waiting to take over in the event of a disk failure. You can also set up alternate root volume groups. That means you can configure a different root volume group, one that contains another version of AIX on another disk or set of disks. Then on different occasions you can boot a node from one root volume group or another. For instance you might want one set of disks for AIX 4.3.2 and another for AIX 4.2.1 so that you can switch from operating with one to the other, perhaps to test a new installation before you use it for production work.

Terminology

Physical Volume	A physical volume is an individual hardware disk drive; it might be internal, SCSI-attached or an external SSA drive.
Volume Group	A volume group is a collection of physical volumes. A physical volume can be in one and only one volume group.
Root Volume Group	A root volume group is a special volume group that contains the AIX base operating system.
Logical Volume	A logical volume is disk space that can be used for file systems, paging, or dump. A logical volume can only be in one volume group, but can span physical volumes.
Logical Partition	A logical partition is a convenient measure of space and is a block of space in a logical volume. Logical partitions can be 1 MB in size and up to 128 MB in size, in powers of two.
Physical Partition	A physical partition is, like a logical partition, a unit of measure. Logical partitions and physical partitions are in a one to one ratio in an environment without mirroring. If mirroring is being used, there will be 2 or 3 physical partitions for each logical partition, depending on the number of copies.
Mirroring	The ability to make a copy of a logical volume or volume group to provide redundancy. AIX allows one (the original), two (the original plus a mirror image), or three (the original plus two mirror images) copies of a logical volume or volume group. The copies are made below the application layer, transparent to the typical user.
Quorum	A quorum is a method used to determine whether or not there are enough physical volumes remaining in a volume group for that volume group to remain online (varied on). Quorum can be turned on or off by the user. If quorum is on, at least 51 percent of the physical volume *votes* must be present or the volume group will be varied offline to maintain

data integrity. If quorum is off, only one vote of all the physical volumes is needed to keep the volume group online.

Note: In general, quorum should be turned off in a mirrored environment and turned on in an environment without mirroring. Quorum is turned on by default during node installation. You can set a mirroring option to turn quorum off when mirroring is initiated and you can change the option to have it turned on when you suspend mirroring.

Mirroring Support in AIX

Redundancy is an important element of modern computer system availability. AIX provides redundant copies of the operating system through disk mirroring. Disk mirroring provides for one or two identical copies of AIX, in addition to the original. A mirrored root volume group means that there are multiple copies of the operating system image available to a workstation or node. Mirrored system images are distributed so that a node can remain in operation even after one of the mirrored units fails. If a physical volume which contains the original copy of AIX should fail, a mirrored copy takes over. This take over is transparent to the user and to any user applications that happen to be running. Through mirroring of the operating system environment, AIX eliminates the possibility that a single physical volume can be a single point of failure for the SP system. PSSP 3.1 provides full support for mirroring on all PSSP 3.1 SP nodes.

Root Volume Group Support in PSSP

PSSP 3.1 supports AIX mirroring and alternate root volume groups on SP nodes by providing commands to:

- Maintain a database of information about the root volume group
- Initiate or suspend mirroring on the nodes
- Maintain the bootlist on the nodes
- Define alternate root volume groups

PSSP 3.1 uses the **Volume_Group** class of the SDR to store mirroring information in volume group objects. Each volume group object contains information that describes a root volume group on a node. When you install PSSP on the control workstation and initialize the SDR, a single volume group object is created with the name of **rootvg** for each node. You can use the **spmkvgobj** command to create additional volume group objects to represent alternate root volume groups for a node. For more information on the **Volume_Group** class, refer to “Class = Volume_Group” on page 575.

An attribute of the **Node** object, the **selected_vg** attribute, designates one of the volume group objects as the currently selected volume group. When the SDR is initialized, all the **selected_vg** attributes are set to **rootvg**, the default root volume group object.

PSSP 3.1 provides the following commands for managing root volume groups:

- Commands to manipulate root volume group information:

spmkvgobj	Create a new Volume_Group object.

spchvgobj	Change Volume_Group information.
sprmvgobj	Remove a Volume_Group object that is not the current volume group.
spbootins	Set boot/install configuration data in the SDR. **Note:** Many attributes that are now associated with the Volume_Group object have been moved from the **spbootins** command to the **spchvgobj** command.

- Commands to initiate or suspend mirroring or to switch between alternate root volume groups::

spmirrorvg	Initiate mirroring.
spunmirrorvg	Suspend mirroring.
spbootlist	Set the bootlist based on specifications in the Node and Volume_Group objects.

Each of these commands accepts a list of nodes as input. See the book *PSSP: Command and Technical Reference* for details of how to use these commands.

While these commands comprise the base support for mirroring and alternate root volume groups in PSSP, you can accomplish some tasks using SP Perspectives, or SMIT. They are interfaces between you and the commands, each being more or less appropriate for you depending on your level of experience. Example tasks in this appendix are shown using the base line commands.

Using Mirrored Root Volume Groups

You can set mirroring options and initiate mirroring on nodes that have already been installed, or you can set mirroring options and have mirroring initiated during installation of a node. You can also suspend mirroring. The mirroring options that you can set using the **spchvgobj** command for a given root volume group are: how many copies you want (2 or 3), which disks to use, and whether quorum is to be on or off.

In general, quorum should be turned off in a mirrored environment and turned on in an environment without mirroring. Quorum is turned on by default during node installation unless you specify **-q false** with the **spchvgobj** command before installation when you first set the mirroring options. After installation, the **-q** flag has no affect except when you initiate or suspend mirroring. To turn quorum off on a node that is already installed, specify **-q false** with the **spchvgobj** command when you set the mirroring options before you initiate mirroring. If you want to turn quorum on again, specify **-q true** with the **spchvgobj** command before you suspend mirroring.

To initiate mirroring of a root volume group on a node that is already installed, use the **spmirrorvg** command after you set mirroring options. To suspend mirroring, use the **spunmirrorvg** command. These commands also issue the **bosboot** and **bootlist** commands on the nodes to create the necessary boot records and to manage the list of bootable devices. If the state of quorum changes on a node as a result of initiating or suspending mirroring, a warning message appears prompting you to reboot the node for the new state of quorum to take effect. See the book

PSSP: Command and Technical Reference for details of how to use these commands.

Examples of some typical tasks follow.

Installing a Node without Mirroring

This sample task installs a node without mirroring and sets the **lppsource_name** attribute for the node.

To install node 3 without mirroring and set lppsource_name to aix432, do the following:

1. Change the volume group **rootvg** to use the lpp source name **aix432** on node 3.

   ```
   spchvgobj -v aix432 -r rootvg -l 3
   ```

2. Change the node 3 bootp response to *install*.

   ```
   spbootins -r install -l 3 -s yes
   ```

3. Network boot the node.

   ```
   nodecond 1 3
   ```

Installing a Node with Mirroring

This is a sample task to install a node with mirroring established from the start.

To install node 5 with two disks for mirroring with the original copy on hdisk0 and a mirror image on hdisk1, do the following:

1. Change the **rootvg** volume group information for node 5 to indicate that you want two copies using physical disks hdisk0 and hdisk1, and you want quorum turned off (quorum is turned on by default during installation).

   ```
   spchvgobj -h hdisk0,hdisk1 -c 2 -r rootvg -q false -l 5
   ```

2. Change the node 5 bootp response to *install*.

   ```
   spbootins -r install -l 5 -s yes
   ```

3. Network boot the node.

   ```
   nodecond 1 5
   ```

Initiating Mirroring on a Node Already Installed without It

This sample task extends the root volume group on a node and starts mirroring. The node has already been installed but without mirroring.

To create a mirror of hdisk0 on hdisk1 for node 3, do the following:

1. Change the **rootvg** volume group on node 3 to have two copies using physical disks hdisk0 and hdisk1, and indicate that you want quorum turned off.

   ```
   spchvgobj -h hdisk0,hdisk1 -c 2 -r rootvg -q false -l 3
   ```

2. Start mirroring on node 3.

   ```
   spmirrorvg -l 3
   ```

3. Reboot node 3 if the state of quorum changes, as indicated by the warning message.

```
cshutdown -r -N 3
```

Restrictions to Mirroring

The following is a list of mirroring restrictions:

- The nodes to be mirrored and the control workstation must be running AIX 4.3.2 or later and PSSP 3.1 or later.
- Mirroring is not performed for dump logical devices.
- AIX supports only double or triple mirroring (the original and one or two more copies of the original).
- AIX does not support mirroring of striped logical volumes.
- Mirroring support does not extend to the control workstation from these commands.
- PSSP supports turning quorum on or off only when mirroring is initiated or suspended.

Using Alternate Root Volume Groups

PSSP 3.1 provides support for alternate root volume groups. This means that you can install several different versions of AIX on different disks that are connected to the same node. That node can then easily be switched from operating with one version to another by rebooting from the disk that has the root volume group of your choice.

Alternate root volume groups can be useful, such as for switching between versions of AIX that have different levels of security, or for quickly backing out from testing new software levels to running production work.

To create alternate root volume groups use the **spmkvgobj** command and to remove them use the **sprmvgobj** command. Use the **spbootins** command to specify which root volume group is to be used in the next install. Use the **spbootlist** command to set the node's bootlist before rebooting. See the book *PSSP: Command and Technical Reference* for details of how to use these commands.

Examples of some typical tasks follow.

Installing a New Root Volume Group

To create a new volume group called **newvg** on hdisk1 with an lpp source name of aix432 on nodes 3 and 5, do the following:

1. Create a new volume group:

   ```
   spmkvgobj -r newvg -h hdisk1 -v aix432 -l 3,5
   ```

2. Change the selected volume group to **newvg**, set the bootp response to *install*, and run the setup_server command:

   ```
   spbootins -c newvg -r install -l 3,5
   ```

   Note: The spbootins command runs the setup_server command by default.

3. Network boot the nodes:

```
nodecond 1 3 &
nodecond 1 5
```

The nodes are installed with the information specified in the **newvg** volume group and will reboot from the specified disks.

Note: The bootp response is automatically set to *disk*.

Rebooting a Node from an Alternate Root Volume Group

To switch from operating with the **newvg** volume group on hdisk1 to operating with the **oldvg** volume group on hdisk0, do the following:

1. Change the current volume group as recorded in the SDR:

   ```
   spbootins -c oldvg -l 3,5
   ```

2. Set the bootlists:

   ```
   spbootlist -l 3,5
   ```

3. Reboot the nodes:

   ```
   cshutdown -r -N 3 5
   ```

Removing an Alternate Root Volume Group

A volume group that is not the current root volume group can be removed. To remove the **newvg** volume group now that it is not the current volume group, issue the following command:

```
sprmvgobj -r newvg -l 3,5
```

Appendix B. SP Daemons

The following daemons are specific to the SP servers and processor nodes:

fault_service_Worm_RTG_SP	Fault-handling daemon for the SP Switch
haemd	Event Manager daemon; matches information about the state of system resources with information about resource conditions that are of interest to client programs to create events; runs on all nodes of a system partition; one instance per system partition runs on the control workstation.
hagsd	Group Services daemon; provides services for coordinating and monitoring changes to the state of a client program that is running on a set of nodes in an SP system; runs on all nodes of a system partition; one instance per system partition runs on the control workstation.
hagsglsmd	A Group Services subsystem daemon that provides global synchronization services; runs on all nodes of a system partition; one instance per system partition runs on the control workstation.
hardmon	Interfaces to the serial port on each SP frame; does tasks such as polling hardware for changes in hardware status, sending state changes to interested parties, sending commands to change power state and key lock position, and providing an interface to the S1 serial port of each processing node.
hatsd	Topology Services daemon; provides information to other PSSP subsystems about the state of the nodes and adapters on the SP system; runs on all nodes of a system partition; one instance per system partition runs on the control workstation.
hrd	Host responds daemon; runs on the control workstation (See Appendix E, “The System Data Repository” on page 535 for details.)
kadmind	Kerberos V4 database administration server.
kerberos	Kerberos authentication server (doesn't run on nodes).
kpropd	Kerberos backup communication daemon (doesn't run on nodes).
pmand	The Event Management client daemon that dispatches actions based on subscribed-to events.
pmanrmd	Provides resource variables for problem management.
s70d	The hardware monitoring daemon used by Hardmon to interface with the RS/6000 Enterprise Server Model S70 and S70 Advanced hardware. The s70d daemon emulates an SP frame and node supervisor. It performs such tasks as: polling the hardware for changes in status, sending state changes back to Hardmon for subsequent dispersal to interested parties, accepting commands from Hardmon to change the power state, and providing an interface to the server's serial port. This daemon is stated by Hardmon. There is no command line interface to this daemon.
sdrd	System Data Repository server.

sp_configd	Creates and sends SNMP traps when selected types of errors are recorded.
splogd	Logs SP hardware state changes, reports SP hardware errors, and provides a state change alert.
spmgrd	An SNMP Manager daemon that runs on the control workstation and interacts with SNMP Agents for extension nodes.
spnkeymand	Per-node key management for SP trusted services.
supfilesrv	Provides services for file collections.
switchtbld	Job Switch Resource Table Services daemon.
sysctld	Sysctl daemon; runs on the control workstation, all nodes, and other RS/6000 computers.
xntpd	Network time protocol daemon, keeps clocks synchronized across the network.

These AIX daemons might also run on the SP servers and processor nodes:

automount	Automount daemon; automatically mounts a directory on request based on map entries.
cron	Runs shell commands at specified intervals.
errdemon	Standard AIX error daemon for recording error log information.
inetd	Provides Internet server management for a network.
named	Provides server functions for the Domain Name Protocol.
nfsd, biod, statd, lockd	Standard NFS daemons.
portmap	Provides **RPC** services.
qdaemon	Schedules print jobs from the **enq** command.
rlogind	Provides **rlogin** services.
rpe.mountd	Responds to client NFS mount requests.
rpestatd, rpe.lockd	Provide System V style of file and record locking with NFS.
sendmail	Routes mail for local or network delivery.
snmpd	Provides the Agent functions of the simple network management protocol.
srcmstr	System resource controller master daemon.
syslogd	Logs system messages
telnetd	Provides **telnet** services.
uprintfd	Constructs and writes kernel messages.
writesrv	Allows the **write** command to send and receive messages.
xmservd	Performance Toolbox.
ypserv	Runs on NIS servers and slaves to provide NIS services.
ypbind	Runs on all NIS clients to communicate with respective server.

Appendix C. Sample Files

afsclient.cust

This is a sample of the **afsclient.cust** file.

```
####################################################################
#
# Module: <afsclient.cust>
#
#-------------------------------------------------------------------
#
# Description: This script is a sample which is designed to be used
#    as a guide for users who may want to install AFS on SP nodes.
#  This script is based on a premise that the Control Workstation (CW)
#  has already been installed and activated as an AFS client.
#
#  This sample script is to be executed by "root" user on the SP node.
#  This may be used with the /tftpboot/script.cust with modification
#  based on the customer requirements and configuration.
#
######################################################################
PATH=/bin:/usr/bin:/etc:/usr/sbin:/usr/bin/X11:/var/sysman:/var/sysman/etc:
/etc/amd:/usr/lpp/ssp/bin:/usr/lpp/ssp/install/bin:/usr/afsws/etc:/usr/vice/etc:

SERVER=‘cat /etc/ssp/server_hostname | cut -d" " -f3’

##################################################################
# Create the required AFS directory on /usr  filesystem. If the /usr is to
# be used as client/server make sure the directories are installed on the
# SP node server first, and then made available to the SP node clients.
# Make sure you have adequate space (about 5000K) is required to load the
# AFS execucatbles and files on the /usr filesystem.
# We will create the directories on /usr, and then copy the required files
# from the CW to the /usr/vice/etc directory on the SP node.
# For our sample configuration we will reference the CW as "$SERVER"
/usr/sbin/chfs  -a size=‘+10000’ /usr

/bin/mkdir -p /usr/vice/etc/C
/bin/mkdir /usr/vice/etc/dkload
# Activate the ticket granting ticket so the remote copy will work successfully
#to bring AFS files from the CW to the SP node.
/usr/lpp/ssp/rcmd/bin/rcmdtgt

# Copy the files from CW /usr/vice/etc directory to the SP node /usr/vice/etc
# directory on the SP node.

/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/CellServDB /usr/vice/etc/CellServDB
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/ThisCell   /usr/vice/etc/ThisCell
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/afsd    /usr/vice/etc/afsd
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/cacheinfo /usr/vice/etc/cacheinfo
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/C/* /usr/vice/etc/C/
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/dkload/* /usr/vice/etc/dkload/
/usr/lpp/ssp/rcmd/bin/rcp $SERVER:/usr/vice/etc/rc.afs  /usr/vice/etc/rc.afs

 ###################################################################
#  This next step will setup the cache that will be used on the SP nodes
#  These values can be modified, based on the amount of users that will be
#  using afs services. We will use the same values as placed on the CW for our
#  configuration being used in the sample script. The values to be modified are
#  the filesystem size for /usr/vice/cache, and /usr/vice/etc/cacheinfo  size.
#  This configuration will setup for a medium afs configuration of 4-8 users.
#  We will use a cacheinfo of 80000K, and filesystem of 90000K.
#  We will create the /usr/vice/cache directory and then create a JFS that will
#  be mounted

/bin/mkdir /usr/vice/cache

/usr/sbin/crfs -v jfs -g rootvg -a size=180000 -m '/usr/vice/cache' -A 'yes' -p 'rw'
/bin/sleep 5
/usr/sbin/mount /usr/vice/cache

#######################################################################
#  This next step will setup the the afs as one of the supported filesystems
#  in the /etc/vfs  file. You can either "edit" and place the information
#  afs     4       none                    none
#  in the file, or append the information using the "echo" command.

/bin/echo "afs     4       none                    none" >> /etc/vfs

#######################################################################
#  This next step will setup the the afs directory, and then activiate the afs
#  daemon (afsd) that connect to the AFS server. This will be executed by
#  starting the /etc/rc.afs script.
#
#  The /etc/rc.afs will setup and execute the AFS libraries to be used as
#  kernel extension in the SP nodes. You may want to use different execution
#  variables based on you configuration and its use with nfs services
#  We expect the files to be available in the /usr/vice/etc/dkload directory
#
#  /usr/vice/etc/dkload/cfgexport -a export.ext
#  /usr/vice/etc/dkload/cfgafs  -a afs.ext
#
#######################################################################

/bin/mkdir  /afs
/usr/vice/etc/rc.afs

/bin/sleep 60
#######################################################################
#  This next step will setup a soft link of the /afs/<cellname>/@sys/usr/afsws
#  directory to /usr/afsws on the SP node. The exact pathnames will need
#  to reflect  the afs configuration cell name, and the system directory.
#  This will be based on where the afsws executables are located.
#
#  /bin/ln -s /afs/<cellname>/@sys/usr/afsws  /usr/afsws
#  My cell execution will be the following:
/bin/ln -s /afs/ppd.pok.ibm.com/rs_aix41/usr/afsws   /usr/afsws

#######################################################################
#  This next step will setup the itab entry for afs in the /etc/inittab file.
#
/usr/sbin/mkitab "rcafs:2:wait:/usr/vice/etc/rc.afs>/dev/console 2>&1 /
# Start AFS daemon "

#######################################################################
#  This next step will add the /usr/afsws/etc /usr/afsws/bin and the
#  /usr/vice/etc into your current path environment. You may want to
#  update the path in .profile, or ksh.rc or other login setup.
PATH=$PATH:/usr/afsws/etc:/usr/afsws/bin:/usr/vice/etc:
```

block_usr_sample

This script creates a file of user names in a column format called called **/tmp/usr.input**. The **usr.input** file can be used with the **spacs_cntrl** command. Once you are comfortable using Login Control, you can uncomment the **spacs_cntrl** command in this script. This file is in **/usr/lpp/ssp/samples**.

```
#!/usr/lpp/ssp/perl/bin/perl
#####################################################
#  Description:
#
#   This sample script will build a file of users from the /etc/passwd
#   file to input to spacs_cntrl.
#
#   The following items should be checked and possibly changed to conform
#   to the policy at your site.
#
#   1)  uid threshhold to start adding users to the file.  Should be large
#       enough to prevent system users such as root, adm, bin, lpd, etc.
#       from being added to the file for spacs_cntrl.  The arbitary value
#       used is 125.
#
#   2)  flags for spacs_cntrl. The logging flag is issued to
#       allow you to follow the actions of spacs_cntrl.  You may wish to
#       remove this flag once you are familiar with running spacs_cntrl.
#       The -s flag suppresses error messages which are logged then -l is
#       issued.
######################################################

# required files.

$usrfile="/tmp/usr.input";
$uidstart = 125;
$allokay = 0;
$syserror = 2;

# open the usr.input file

unless ( open(USRFILE,">$usrfile") ) {
      print "block_usr:  Cannot open usr.input file.\n";
      exit ($syserror);
      }

# write any names with a uid of 125 or above into file

while ( ($uname,$passwd,$uid) = getpwent ) {
    if ( $uid >= $uidstart ) {
      print USRFILE $uname,"\n";
    }
}

close(USRFILE);

# make sure file has entries

if ( -z $usrfile ) {
   print "block_usr:  No entries in $usrfile.  Not executing spacs_cntrl.\n";
   exit($syserror);
}
```

```
# Uncomment the following for this script to automatically run the spacs_cntrl command
# and block users.
# issue spacs_cntrl to block users in the file.

#system "/usr/lpp/ssp/bin/spacs_cntrl -s -l -f $usrfile block";
#$rc=$?;
#if ( $rc != 0 ) {
#   $rc = ($rc >> 8);
#   print "block_usr:  Possible error from spacs_cntrl.  Return code = $rc\n";
#   exit($rc);
#}

exit ($allokay)
```

bootptab.info File

If it exists, the **/etc/bootptab.info** file is read by the **sphrdwrad** command for hardware Ethernet addresses to be placed in the SDR. If it does not exist, then the **sphrdwrad** command still runs but takes longer to collect the information from the hardware.

Each line should list an SP node, specified by node number or *frame,slot* followed by a blank and the hardware Ethernet address. The file should look similar to this:

```
17 02608C2E48D9
19 02608C2D6712
21 02608C2E49A4
23 02608C2E48E2
```

ibmSPDepNode.my

A copy of this MIB can be found in file **/usr/lpp/ssp/config/spmgrd/ibmSPDepNode.my**. The file contains configuration information for a dependent node adapter on a dependent node. It is used by the **spmgrd** daemon to send configuration attribute values to the SNMP Agent running on the dependent node.

```
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--
-- Script Name:  depnode.my
--
-- Description:
--      definition of the depnode mib.
--
-- “@(#)75 1.2
 src/ssp/spmgr/src/ibmSPDepNode.my,spmgr, ssp_rspr, rsprt2d9 2/7/9

DEPNODE-MIB  DEFINITIONS ::= BEGIN

IMPORTS
        Counter, Gauge, TimeTicks, IpAddress, DisplayString, enterprises
                FROM RFC1155-SMI
        TRAP-TYPE
```

```
                FROM RFC1215;

ibm             OBJECT IDENTIFIER ::= { enterprises 2 }

ibmProd         OBJECT IDENTIFIER ::= { ibm 6 }

ibmSP           OBJECT IDENTIFIER ::= { ibmProd 117 }

---------------------------------
--

--              IBM NODEDEP MIB

--
ibmSPDepNode       OBJECT IDENTIFIER ::= { ibmSP 4 }

ibmSPDepNodeTable OBJECT-TYPE
      SYNTAX  SEQUENCE OF IbmSPDepNodeEntry
      ACCESS  not-accessible
      STATUS  mandatory
      DESCRIPTION
              "This entity's table of dependent secondary nodes
               attached to IBM SP switch networks."
      ::= { ibmSPDepNode 1 }

ibmSPDepNodeEntry OBJECT-TYPE
      SYNTAX  IbmSPDepNodeEntry
      ACCESS  not-accessible
      STATUS  mandatory
      DESCRIPTION
              "Configuration information for a dependent
               secondary node on SP switch network."
      INDEX { ibmSPDepNodeName }
      ::= { ibmSPDepNodeTable 1 }

IbmSPDepNodeEntry ::=
       SEQUENCE {
       ibmSPDepNodeName
          DisplayString,
       ibmSPDepNodeNumber
          INTEGER,
       ibmSPDepSwToken
          OCTET STRING,
       ibmSPDepSwARP
          INTEGER,
       ibmSPDepSwNodeNumber
          INTEGER,
       ibmSPDepIPaddr
          IpAddress,
       ibmSPDepNetMask
          IpAddress,
       ibmSPDepIPMaxLinkPkt
          INTEGER,
       ibmSPDepIPHostOffset
          INTEGER,
       ibmSPDepConfigState
          INTEGER,
       ibmSPDepSysName
          DisplayString,
       ibmSPDepNodeState
          INTEGER,
       ibmSPDepSwChipLink
          INTEGER,
       ibmSPDepNodeDelay
```

```
           INTEGER,
        ibmSPDepAdminStatus
           INTEGER
        }

ibmSPDepNodeName OBJECT-TYPE
      SYNTAX  DisplayString
      ACCESS  read-only
      STATUS  mandatory
      DESCRIPTION
              "Identifier assigned to this node in its
               system's administrative environment."
      ::= { ibmSPDepNodeEntry 1 }

ibmSPDepNodeNumber OBJECT-TYPE
      SYNTAX  INTEGER
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "Relative node number assigned to this node in the SP system.
               Note that this is distinct from switch node number."
      ::= { ibmSPDepNodeEntry 2 }

ibmSPDepSwToken OBJECT-TYPE
      SYNTAX  OCTET STRING (SIZE(10))
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "Opaque correlator assigned in the SP system
               for this node's switch connection."
      ::= { ibmSPDepNodeEntry 3 }

ibmSPDepSwARP OBJECT-TYPE
      SYNTAX  INTEGER {
                  disabled(1),
                  enabled(2)
              }
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "Indicates whether ARP is enabled for the partition
               of the switch network that contains the associated
               dependent secondary node.
               NOTE: An SNMP Agent may be responsible for switch
               nodes in several SP system partitions, and ARP
               may be enabled in none, some, or all of the partitions.

               A value of disabled(1) indicates that ARP is
               not to be used to resolve network protocol
               addresses to switch node numbers for the switch
               network.  Instead, the mapping of IP addresses
               to switch node numbers is determined via the
               algorithm in the description of ibmSPDepIPHostOffset.

               A value of enabled(2) indicates that ARP is
               to be used to resolve network protocol
               addresses to switch node numbers for the switch
               network."
      ::= { ibmSPDepNodeEntry 4 }

ibmSPDepSwNodeNumber OBJECT-TYPE
      SYNTAX  INTEGER (0..65535)
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "The switch node number of the associated SP switch
               interface.  In common networking terminology,
               this is the physical address for the interface
               on the SP switch network, and is also called
               the Node Device ID in the SP dependent node
               architecture."
      ::= { ibmSPDepNodeEntry 5 }

ibmSPDepIPaddr OBJECT-TYPE
      SYNTAX  IpAddress
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "The IP address for the associated SP switch interface."
      ::= { ibmSPDepNodeEntry 6 }

ibmSPDepNetMask OBJECT-TYPE
      SYNTAX  IpAddress
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
               "The subnet mask associated with the IP address of
                this entry.  The value of the mask is an IP
                address with all the network bits set to 1 and all
                the host bits set to 0."
      ::= { ibmSPDepNodeEntry 7 }

ibmSPDepIPMaxLinkPkt OBJECT-TYPE
      SYNTAX  INTEGER
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "The maximum number of bytes in the data portion of
               link-layer packets for IP datagrams on the
               SP switch network."
      ::= { ibmSPDepNodeEntry 8 }

ibmSPDepIPHostOffset OBJECT-TYPE
      SYNTAX  INTEGER
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
              "This value is the difference between switch node
               numbers and the host portion of the corresponding
               IP addresses when ARP is disabled on the SP switch
               network.  It is the value to subtract from the
               host portion of an IP address to calculate the
               corresponding switch node number."
      ::= { ibmSPDepNodeEntry 9 }

ibmSPDepConfigState OBJECT-TYPE
      SYNTAX  INTEGER {
                  notConfigured(1),
                  firmwareLoadFailed(2),
                  driverLoadFailed(3),
                  diagnosticFailed(4),
                  microcodeLoadFailed(5),
                  fullyConfigured(6)
              }
      ACCESS  read-only
      STATUS  mandatory
      DESCRIPTION
              "This value indicates the final configuration state
```

```
                of the corresponding SP switch interface."
         ::= { ibmSPDepNodeEntry 10 }

   ibmSPDepSysName OBJECT-TYPE
         SYNTAX  DisplayString
         ACCESS  read-write
         STATUS  mandatory
         DESCRIPTION
               "The fully-qualified domain name of the SP system
                partition that contains this dependent node. This
                name is administratively assigned in the SP system."
         ::= { ibmSPDepNodeEntry 11 }

   ibmSPDepNodeState OBJECT-TYPE
         SYNTAX  INTEGER {
                   nodeUp(1),
                   nodeDown(2)
               }
         ACCESS  read-only
         STATUS  mandatory
         DESCRIPTION
               "This value indicates the state of the dependent
                node with respect to its capability to handle
                Switch Manager protocol via its SP switch interface.

                A value of nodeUp(1) indicates that the node has
                been reinitialized or reconfigured sufficiently
                to handle the Switch Manager protocol to unfence
                the node if it were previously fenced from the
                SP switch network.

                A value of nodeDown(2) indicates that the node is
                no longer able to handle Switch Manager protocol
                messages on the SP switch network."
         ::= { ibmSPDepNodeEntry 12 }

   ibmSPDepSwChipLink OBJECT-TYPE
         SYNTAX  INTEGER
         ACCESS  read-write
         STATUS  mandatory
         DESCRIPTION
               "The send port number for packets from the
                adjacent switch chip to the dependent node.
                The dependent node needs this value to build
                the packet that it sends to the adjacent
                switch chip to trigger that chip to reply
                with a clock synchronization packet."
         ::= { ibmSPDepNodeEntry 13 }

   ibmSPDepNodeDelay OBJECT-TYPE
         SYNTAX  INTEGER
         ACCESS  read-write
         STATUS  mandatory
         DESCRIPTION
               "This value is an estimate of how many clock
                cycles elapse before a clock synchronization packet
                sent from the adjacent switch chip to the dependent node
                results in loading of the switch time-of-day register
                for the node.

                The dependent node needs this value to build
                the packet that it sends to the adjacent
                switch chip to trigger that chip to reply with
                a clock synchronization packet."
```

```
      ::= { ibmSPDepNodeEntry 14 }

ibmSPDepAdminStatus OBJECT-TYPE
      SYNTAX  INTEGER {
                up(1),
                down(2),
                reconfigure(3)
              }
      ACCESS  read-write
      STATUS  mandatory
      DESCRIPTION
             "This value indicates the desired state of the dependent
             node with respect to its capability to handle the
             Switch Manager protocol via its SP switch interface.
             If the dependent node is not in the desired state,
             then the SNMP Agent triggers actions to change the state
             to the described state.

             A value of up(1) indicates that the node should be
             initialized and configured sufficiently to handle
             the Switch Manager protocol.

             A value of down(2) indicates that the node should be
             reset such that it is not able to receive and handle
             Switch Manager protocol messages on the SP switch
             network.

             A value of reconfigure(3) indicates that the SNMP Agent
             must send the switchInfoNeeded trap to request new
             SP switch configuration information for the dependent
             node.  This causes the SNMP Manager to send the new
             configuration information for the dependent node MIB
             objects via set-request PDU(s).  Once the new values
             are set by the SNMP Manager, the SNMP Agent reinitializes
             and reconfigures the dependent node sufficiently to
             handle the Switch Manager protocol."
      ::= { ibmSPDepNodeEntry 15 }

-- IBM enterprise-specific traps dependent secondary nodes on SP switch:

switchInfoNeeded TRAP-TYPE
      ENTERPRISE  ibmSP
      VARIABLES   { ibmSPDepNodeName }
      DESCRIPTION
              "A switchInfoNeeded trap signifies that the sending
               protocol entity needs SP switch configuration
               information for a dependent secondary node within
               the sender's configuration."
      ::= 1

switchConfigState TRAP-TYPE
      ENTERPRISE  ibmSP
      VARIABLES   { ibmSPDepConfigState }
      DESCRIPTION
              "A switchConfigState trap indicates the final
               configuration state of a dependent secondary node's
               SP switch interface."
      ::= 2

switchNodeUp TRAP-TYPE
      ENTERPRISE  ibmSP
      VARIABLES   { ibmSPDepNodeName }
      DESCRIPTION
              "A switchNodeUp trap indicates that a dependent
```

```
                secondary node in the sender's configuration has
                just been reinitialized or reconfigured and is able
                to handle SP Switch Manager protocol messages."
      ::= 3

switchNodeDown TRAP-TYPE
      ENTERPRISE  ibmSP
      VARIABLES   { ibmSPDepNodeName }
      DESCRIPTION
               "A switchNodeDown trap indicates that a dependent
                secondary node in the sender's configuration
                is no longer able to handle Switch Manager protocol
                messages on the switch network."
      ::= 4

END
```

ibmSPMIB.my

A copy of this MIB can be found in file **/usr/lpp/ssp/config/snmp_proxy/ibmSPMIB.my**. The file defines SP-specific information for the creation of SNMP traps for the SP from AIX Error Log and Event Management Events. It also contains information about the nodes and the control workstation that make up the SP. The MIB is supported by the **sp_configd** daemon.

```
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--
-- Script Name:  ibmSPMIB.my
--
-- Description:
-- definition of the ibmSP mib.
--

IBMSP-MIB  DEFINITIONS ::= BEGIN

IMPORTS
        Counter, Gauge, TimeTicks, IpAddress, DisplayString, enterprises
  FROM RFC1155-SMI
 TRAP-TYPE
  FROM RFC1215;

ibm     OBJECT IDENTIFIER ::= { enterprises 2 }

ibmProd OBJECT IDENTIFIER ::= { ibm 6 }

ibmSP   OBJECT IDENTIFIER ::= { ibmProd 117 }

----------------------------------------------------------------------
--

--              IBM SP MIB
```

```
--

ibmSPConfig OBJECT IDENTIFIER ::= { ibmSP 1 }

ibmSPhostnodenumber OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  "A number from 0 to the total number of slots.  It identifies
  the relative node number assigned to this processor."
 ::= { ibmSPConfig 1 }

ibmSPhostpartaddr OBJECT-TYPE
 SYNTAX IpAddress
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "ip address assigned to the system partition in which this host
  resides. If this host is acting as a control workstation (i.e.
  the value of ibmSPhostnodenumber.0 is 0), this will be the ip
  address of the default partition."
 ::= { ibmSPConfig 2 }

ibmSPCWScodeversion OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The ssp release that is installed on the control workstation.
   Values are of the form 2.0, 2.1, etc. A NULL value means the
   release is not known."
 ::= { ibmSPConfig 3 }

ibmSPprimaryCWSname OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "hostname of the primary control workstation."
 ::= { ibmSPConfig 4 }

ibmSPprimaryCWSoperstatus OBJECT-TYPE
 SYNTAX INTEGER {
  up(1),
  down(2)
  }
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "operational state of the primary control workstation."
 ::= { ibmSPConfig 5 }

ibmSPbackupCWSname OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “hostname of the backup control workstation.”
 ::= { ibmSPConfig 6 }

ibmSPbackupCWSoperstatus OBJECT-TYPE
 SYNTAX INTEGER {
  up(1),
  down(2)
  }
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “operational state of the backup control workstation.”
 ::= { ibmSPConfig 7 }

ibmSPSystemTable OBJECT-TYPE
 SYNTAX SEQUENCE OF IbmSPNodeEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “A list of SPNodeEntrys.”
 ::= { ibmSPConfig 8 }

ibmSPNodeEntry OBJECT-TYPE
 SYNTAX IbmSPNodeEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “Identifies a processor node residing in an SP frame.”
 INDEX { ibmSPpartitionaddr, ibmSPnodenumber }
 ::= { ibmSPSystemTable 1 }

IbmSPNodeEntry ::=
 SEQUENCE {
   ibmSPpartitionaddr
    IpAddress,
   ibmSPnodenumber
    INTEGER,
   ibmSPframenumber
    INTEGER,
   ibmSPslotnumber
    INTEGER,
   ibmSPslotsused
    INTEGER,
   ibmSPinitialhostname
    DisplayString,
   ibmSPreliablehostname
    DisplayString,
   ibmSPsysparname
    DisplayString,
   ibmSPcodeversion
    DisplayString
   }

ibmSPpartitionaddr OBJECT-TYPE
 SYNTAX IpAddress
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “ip address assigned to the partition in which this node resides.”
 ::= { ibmSPNodeEntry 1 }

ibmSPnodenumber OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “A number from 1 to the total number of slots.  It identifies
  the relative node number assigned to the processor.”
 ::= { ibmSPNodeEntry 2 }

ibmSPframenumber OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “A number from 1 to the number of frames.  It identifies
  the number of the frame in which the processor node resides.”
 ::= { ibmSPNodeEntry 3 }

ibmSPslotnumber OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “A number from 1 to the number of slots in a frame.  It
  identifies the number of the first slot occupied by the
  processor node within the frame.”
 ::= { ibmSPNodeEntry 4 }

ibmSPslotsused OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “A number from 1 to two.  It identifies the number of slots
  occupied by the processor.”
 ::= { ibmSPNodeEntry 5 }

ibmSPinitialhostname OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “The initial hostname assigned to the node during the SP customization
  phase.”
 ::= { ibmSPNodeEntry 6 }

ibmSPreliablehostname OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  “The hostname associated with the SP ethernet.”
 ::= { ibmSPNodeEntry 7 }
```

```
ibmSPsysparname OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS read-only
 STATUS mandatory
 DESCRIPTION
  "The name of the system partition containing this processor
  node."
 ::= { ibmSPNodeEntry 8}

ibmSPcodeversion OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The ssp release that is installed on the processor node.
  Values are of the form 2.0, 2.1, etc. A NULL value means the
  release is not known."
 ::= { ibmSPNodeEntry 9 }

    -- The format of traps containing errlog entries whose tmplates
    -- are defined with 'Alert=yes'.

-- ibmSPErrlogTrap TRAP-TYPE
-- ENTERPRISE ibmSP
-- VARIABLES  { ibmSPellabel, ibmSPelidentifier, ibmSPeldatetime,
--    ibmSPelsequencenum, ibmSPelmachineid, ibmSPelnodeid,
--    ibmSPelclass, ibmSPeltype, ibmSPelresource,
--    ibmSPelrscclass, ibmSPelrsctype, ibmSPellocation,
--    ibmSPelvpd, ibmSPetdescription, ibmSPetprobcauses,
--    ibmSPetusercauses, ibmSPetuseraction, ibmSPetinstcauses,
--    ibmSPetinstaction, ibmSPetfailcauses, ibmSPetfailaction,
--    ibmSPetdetaildata}
-- DESCRIPTION
--    "These traps contain the contents of errlog entries formatted
--    into objects defining the contents of the errlog entry.
--    Since any single errlog entry does not contain all of the
--    fields defined in the collection of errlog templates, when a
--    object contains a null value, it will not be included in the
--    trap."
--    ::= ibmSPelidentifier.0

ibmSPErrlogVars OBJECT-TYPE
 SYNTAX SEQUENCE OF IbmSPErrlogEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  "A single SPNodeErrlogEntry."
 ::= { ibmSP 2 }

IbmSPErrlogEntry ::=
 SEQUENCE {
  ibmSPellabel
   DisplayString,
  ibmSPelidentifier
   DisplayString,
  ibmSPeldatetime
   DisplayString,
  ibmSPelsequencenum
```

```
   DisplayString,
  ibmSPelmachineid
   DisplayString,
  ibmSPelnodeid
   DisplayString,
  ibmSPelclass
   DisplayString,
  ibmSPeltype
   DisplayString,
  ibmSPelresource
   DisplayString,
  ibmSPelrscclass
   DisplayString,
  ibmSPelrsctype
   DisplayString,
  ibmSPellocation
   DisplayString,
  ibmSPelvpd
   DisplayString,
  ibmSPetdescription
   DisplayString,
  ibmSPetprobcauses
   DisplayString,
  ibmSPetusercauses
   DisplayString,
  ibmSPetuseraction
   DisplayString,
  ibmSPetinstcauses
   DisplayString,
  ibmSPetinstaction
   DisplayString,
  ibmSPetfailcauses
   DisplayString,
  ibmSPetfailaction
   DisplayString,
  ibmSPetdetaildata
   DisplayString
  }

ibmSPellabel OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The label associated with the error identifier defined by
  the ibmSPelidentifier object."
 ::= { ibmSPErrlogVars 1 }

ibmSPelidentifier OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "A unique identifier defining the type of error entry written
  to the system error log existing on the host from which the
  trap originated."
 ::= { ibmSPErrlogVars 2 }
```

```
ibmSPeldatetime OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “A timestamp identifying the time that this error log entry
  was written to the system error log.  It is of the form:
  day   month   day_of_month   hour:min:sec“
 ::= { ibmSPErrlogVars 3 }

ibmSPelsequencenum OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “A decimal number which is the sequence number assigned to this
  entry.  This is the value specified on the -l switch of the
  errpt command used to obtain the trap data on the host from
  which the trap originated.”
 ::= { ibmSPErrlogVars 4 }

ibmSPelmachineid OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “A decimal number which is the machine ID of the host on which
  the trap originated. This is the value returned by the AIX
  ‘uname -m’ command when issued on the host from which the trap
  originated.”
 ::= { ibmSPErrlogVars 5 }

ibmSPelnodeid OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “An alpha-numeric string which is the node ID of the host on
  which the trap originated.  This is the value returned by the AIX
  ‘uname -m’ command when issued on the host from which the trap
  originated.”
 ::= { ibmSPErrlogVars 6 }

ibmSPelclass OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “An alphabetic string which is the error class of this entry:
  H (hardware), S (software), O (errlogger command messages).”
 ::= { ibmSPErrlogVars 7 }

ibmSPeltype OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “An alphabetic string which is the severity of the error entry:
```

```
  ‘PEND’ (impending loss of availability), ‘PERF’ (unacceptable
  performance degradation), ‘PERM’ (permanent), ‘TEMP’ (temporary),
  ‘UNKN’ (unknown).”
 ::= { ibmSPErrlogVars 8 }

ibmSPelresource OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The resource name associated with the error. For hardware
  errors this is a device name, for software errors this is
  the name of the failing executable, for operator command
  messages this is ‘OPERATOR’.”
 ::= { ibmSPErrlogVars 9 }

ibmSPelrscclass OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The resource class associated with the error. For hardware
  errors this is a device class (or ‘NONE’).”
 ::= { ibmSPErrlogVars 10 }

ibmSPelrsctype OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The resource type associated with the error.  For hardware
  errors this is a device type (or ‘NONE’), for software errors
  (when specified) this is an LPP.”
 ::= { ibmSPErrlogVars 11 }

ibmSPellocation OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “For hardware errors, information about the location of the
  failing device (or ‘NONE’).”
 ::= { ibmSPErrlogVars 12 }

ibmSPelvpd OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “IBM or user supplied vital product data.”
 ::= { ibmSPErrlogVars 13}

ibmSPetdescription OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “Error description.”
 ::= { ibmSPErrlogVars 14}

ibmSPetprobcauses OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "Probable causes of the error."
 ::= { ibmSPErrlogVars 15 }

ibmSPetusercauses OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "User actions which may have caused the error."
 ::= { ibmSPErrlogVars 16 }

ibmSPetuseraction OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "Recommended actions the user may take to correct the error."
 ::= { ibmSPErrlogVars 17 }

ibmSPetinstcauses OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "Installation causes of the error."
 ::= { ibmSPErrlogVars 18 }

ibmSPetinstaction OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "User actions which may have been performed during installation
  to cause the error."
 ::= { ibmSPErrlogVars 19 }

ibmSPetfailcauses OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "A list of candidates which may be the source of the error."
 ::= { ibmSPErrlogVars 20 }

ibmSPetfailaction OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "A list of reccommended actions which may be taken to correct
  the possible failures."
 ::= { ibmSPErrlogVars 21 }

ibmSPeldetaildata OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "Detailed data about this particular error."
 ::= { ibmSPErrlogVars 22 }

ibmSPEMVariables OBJECT IDENTIFIER ::= { ibmSP 3 }

-- The format of traps containing errlog entries whose tmplates
-- are defined with 'Alert=yes'.

--  ibmSPEMEventTrap TRAP-TYPE
--  ENTERPRISE ibmSP
--  ibmSPEMEventVarValue
--  DisplayString,
--  ibmSPEMEventPredicate
--  DisplayString
--  VARIABLES  { ibmSPEMEventID, ibmSPEMEventFlags, ibmSPEMEventTime,
--   ibmSPEMEventLocation, ibmSPEMEventPartitionAddress,
--   ibmSPEMEventVarsTableName, ibmSPEMEventVarsTableInstanceID,
--   ibmSPEMEventVarName, ibmSPEMEventVarValueInstanceVector,
--   ibmSPEMEventVarValuesTableInstanceID,
--   ibmSPEMEventVariableValue, ibmSPEMEventPredicate,
--  DESCRIPTION
--   "These traps contain the contents of events generated from the
--   PSSP Event Manager.  The events have been formatted
--   into objects defining the contents of the event and where
--   the variable pertaining to the event and its value are located
--   in the ibmSP mib.
--  ::= ibmSPEMEventID.0

ibmSPEMEvent OBJECT-TYPE
 SYNTAX SEQUENCE OF IbmSPEMEventEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  "A single IbmSPEMEventEntry."
 ::= { ibmSPEMVariables 1 }

ibmSPEMEventEntry ::=
 SEQUENCE {
  ibmSPEMEventID
   INTEGER,
  ibmSPEMEventFlags
   INTEGER,
  ibmSPEMEventTime
   TimeTicks,
  ibmSPEMEventLocation
   INTEGER,
  ibmSPEMEventPartitionAddress
   IpAddress,
  ibmSPEMEventVarsTableName
   DisplayString,
  ibmSPEMEventVarsTableInstanceID
```

```
   DisplayString,
  ibmSPEMEventVarName
   DisplayString,
  ibmSPEMEventVarValueInstanceVector
   DisplayString,
  ibmSPEMEventVarValuesTableInstanceID
   DisplayString,
  ibmSPEMEventVarValue
   DisplayString,
  ibmSPEMEventPredicate
   DisplayString
  }

ibmSPEMEventID OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The trap identifier assigned to the occurence of the Event."
 ::= { ibmSPEMEvent 1}

ibmSPEMEventFlags OBJECT-TYPE
 SYNTAX INTEGER {
  re-arm(1),
  false-predicate(2),
  unregister-event(4)
  }
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "EM Flags."
 ::= { ibmSPEMEvent 2}

ibmSPEMEventTime OBJECT-TYPE
 SYNTAX TimeTicks
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "Elapsed time between the activation of the SP proxy sub-agent
  and the occurence of the event."
 ::= { ibmSPEMEvent 3}

ibmSPEMEventLocation OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The number of the SP node from which the event was generated."
 ::= { ibmSPEMEvent 4}

ibmSPEMEventPartitionAddress OBJECT-TYPE
 SYNTAX IpAddress
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The ip address of the SP partition from which the event was
  generated."
 ::= { ibmSPEMEvent 5}
```

```
ibmSPEMEventVarsTableName OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The name of the table in the SP MIB in which contains the variable
  definition objects."
 ::= { ibmSPEMEvent 6}

ibmSPEMEventVarsTableInstanceID OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The instance identifier used to locate the row in the table named
  by the ibmSPEMEventVarsTableName object value which contains
  further information about the EM Event variable definition."
 ::= { ibmSPEMEvent 7}

ibmSPEMEventVarName OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The name of the EM variable  about which the event is recorded."
 ::= { ibmSPEMEvent 8}

ibmSPEMEventVarValueInstanceVector OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The instantiation vector of the EM variable instance that resulted
  in the event."
 ::= { ibmSPEMEvent 9}

ibmSPEMEventVarValuesTableInstanceID OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The instance identifier used to locate the row in the
  ibmSPEMVarValuesTable identifying for which instantiation of the named
  EM variable the value is reported. This is used to obtain the current
  variable value in the table to see if it has changed since the time
  the trap was issued."
 ::= { ibmSPEMEvent 10}

ibmSPEMEventVarValue OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "The value of the variable instance at the time of the event."
 ::= { ibmSPEMEvent 11}

ibmSPEMEventPredicate OBJECT-TYPE
```

```
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The predicate string which caused the event.”
 ::= { ibmSPEMEvent 12}

ibmSPEMNodeDepVarsTable OBJECT-TYPE
 SYNTAX SEQUENCE OF IbmSPEMNodeDepVarEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “A table of node-dependent EM Variable attributes. Variables
  in this table are only instantiated on the node containing the
  resource monitor. See the ibmSPEMNodeDepVarLocator object
  description.”
 ::= { ibmSPEMVariables 2 }

ibmSPEMNodeDepVarEntry OBJECT-TYPE
 SYNTAX IbmSPEMNodeDepVarEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “The attributes of an event manager variable.  Each octet of
  the variable-length index string is encoded in a separate
  sub-identifier. The number of the sub-identifiers in the index
  is IMPLIED.”
 INDEX { ibmSPEMNodeDepVarName }
 ::= { ibmSPEMNodeDepVarsTable 1 }

IbmSPEMNodeDepVarEntry ::=
 SEQUENCE {
  ibmSPEMNodeDepVarName
   DisplayString,
  ibmSPEMNodeDepVarDescr
   DisplayString,
  ibmSPEMNodeDepVarType
   DisplayString,
  ibmSPEMNodeDepVarDataType
   DisplayString,
  ibmSPEMNodeDepVarSBSFormat
   DisplayString,
  ibmSPEMNodeDepVarInitValue
   DisplayString,
  ibmSPEMNodeDepVarCurValueIndex
   INTEGER,
  ibmSPEMNodeDepVarClass
   DisplayString,
  ibmSPEMNodeDepVarVecElDefn
   DisplayString,
  ibmSPEMNodeDepVarVecElDescr
   DisplayString,
  ibmSPEMNodeDepVarPTXName
   DisplayString,
  ibmSPEMNodeDepVarDefPred
   DisplayString,
  ibmSPEMNodeDepVarEventDescr
   DisplayString,
  ibmSPEMNodeDepVarLocator
   DisplayString,
  ibmSPEMNodeDepVarOrderGroup
   DisplayString
  }

ibmSPEMNodeDepVarName OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "A resource variable name as defined to the Event Manager."
 ::= { ibmSPEMNodeDepVarEntry 1 }

ibmSPEMNodeDepVarDescr OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "A description of the variable, including its semantics."
 ::= { ibmSPEMNodeDepVarEntry 2 }

ibmSPEMNodeDepVarType OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "One of the strings Counter, Quantity or State."
 ::= { ibmSPEMNodeDepVarEntry 3 }

ibmSPEMNodeDepVarDataType OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "One of the strings long, float or SBS. SBS is only permitted
  for a variable of the type State. If the value of this
  object is SBS, then the definitions of the structured fields
  that comprise the structured byte string contained in the
  ibmSPEMNodeDepVarSBSFormat object."
 ::= { ibmSPEMNodeDepVarEntry 4 }

ibmSPEMNodeDepVarSBSFormat OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  "If the ibmSPEMNodeDepVarDataType object with the corresponding
  instance id has a value of SBS, then this object dscribes the
  structured fields within the variable. Included for each structured
  field is the structured field name, followed by an equal sign,
  followed by the data type for the field. The structured fields
  are defined sequentially beginning with sequence number 0."
 ::= { ibmSPEMNodeDepVarEntry 5 }

ibmSPEMNodeDepVarInitValue OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The initial value of a resource variable before it is observed
  for the first time.”
 ::= { ibmSPEMNodeDepVarEntry 6 }

ibmSPEMNodeDepVarCurValueIndex OBJECT-TYPE
 SYNTAX INTEGER
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “An index into the ibmSPEMVarValuesTable to locate value
  instances for this variable.”
 ::= { ibmSPEMNodeDepVarEntry 7 }

ibmSPEMNodeDepVarClass OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The name of the class to which this resource variable belongs.”
 ::= { ibmSPEMNodeDepVarEntry 8 }

ibmSPEMNodeDepVarVecElDefn OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The name(s) of instantiation vector elements associated with the
  resource variable.”
 ::= { ibmSPEMNodeDepVarEntry 9 }

ibmSPEMNodeDepVarVecElDescr OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “A description of the instantiation vector elements associated with
  the resource variable.”
 ::= { ibmSPEMNodeDepVarEntry 10 }

ibmSPEMNodeDepVarPTXName OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The name used to read and write the resource variable in the PTX
  shared memory.”
 ::= { ibmSPEMNodeDepVarEntry 11 }

ibmSPEMNodeDepVarDefPred OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The default predicate to be applied to the resource variable.”
 ::= { ibmSPEMNodeDepVarEntry 12 }
```

```
ibmSPEMNodeDepVarEventDescr OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “A description of the event generated by the application of the
  default predicate.”
 ::= { ibmSPEMNodeDepVarEntry 13 }

ibmSPEMNodeDepVarLocator OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The name of the vector element whose value is the number of the
  node containing the variable instance.”
 ::= { ibmSPEMNodeDepVarEntry 14 }

ibmSPEMNodeDepVarOrderGroup OBJECT-TYPE
 SYNTAX DisplayString
 ACCESS  read-only
 STATUS mandatory
 DESCRIPTION
  “The name of an Availability group. All events generated by the
  default predicates of resource variables within this order group
  name are guaranteed ordered delivery with respect to one
  another.”
 ::= { ibmSPEMNodeDepVarEntry 15 }

ibmSPEMNodeIndepVarsTable OBJECT-TYPE
 SYNTAX SEQUENCE OF IbmSPEMNodeIndepVarEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “A table of node-independent EM Variable attributes.  No EM Locator
  element is defined for these variables so the location of the
  resource monitor is unknown within the partition. Variables
  in this table are only instantiated on the Control Work Station.
  See the ibmSPEMNodeDepVarLocator object description.”
 ::= { ibmSPEMVariables 3 }

ibmSPEMNodeIndepVarEntry OBJECT-TYPE
 SYNTAX IbmSPEMNodeIndepVarEntry
 ACCESS  not-accessible
 STATUS mandatory
 DESCRIPTION
  “The attributes of an event manager variable.  Each octet of
  the variable-length index string is encoded in a separate
  sub-identifier. The number of the sub-identifiers in the index
  is IMPLIED.”
 INDEX { ibmSPEMNodeIndepPartaddr, ibmSPEMNodeIndepVarName }
 ::= { ibmSPEMNodeIndepVarsTable 1 }

IbmSPEMNodeIndepVarEntry ::=
 SEQUENCE {
  ibmSPEMNodeIndepPartaddr
   IpAddress,
  ibmSPEMNodeIndepVarName
```

```
    DisplayString,
   ibmSPEMNodeIndepVarDescr
    DisplayString,
   ibmSPEMNodeIndepVarType
    DisplayString,
   ibmSPEMNodeIndepVarDataType
    DisplayString,
   ibmSPEMNodeIndepVarSBSFormat
    DisplayString,
   ibmSPEMNodeIndepVarInitValue
    DisplayString,
   ibmSPEMNodeIndepVarCurValueIndex
    INTEGER,
   ibmSPEMNodeIndepVarClass
    DisplayString,
   ibmSPEMNodeIndepVarVecElDefn
    DisplayString,
   ibmSPEMNodeIndepVarVecElDescr
    DisplayString,
   ibmSPEMNodeIndepVarPTXName
    DisplayString,
   ibmSPEMNodeIndepVarDefPred
    DisplayString,
   ibmSPEMNodeIndepVarEventDescr
    DisplayString,
   ibmSPEMNodeIndepVarOrderGroup
    DisplayString
   }

 ibmSPEMNodeIndepPartaddr OBJECT-TYPE
  SYNTAX IpAddress
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   "ip address assigned to the system partition in which the
   this resource variable resides."
  ::= { ibmSPEMNodeIndepVarEntry 1 }

 ibmSPEMNodeIndepVarName OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   "A resource variable name as defined to the Event Manager."
  ::= { ibmSPEMNodeIndepVarEntry 2 }

 ibmSPEMNodeIndepVarDescr OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   "A description of the variable, including its semantics."
  ::= { ibmSPEMNodeIndepVarEntry 3 }

 ibmSPEMNodeIndepVarType OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “One of the strings Counter, Quantity or State.”
  ::= { ibmSPEMNodeIndepVarEntry 4 }

 ibmSPEMNodeIndepVarDataType OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “One of the strings long, float or SBS. SBS is only permitted
   for a variable of the type State. If the value of this
   object is SBS, then the definitions of the structured fields
   that comprise the structured byte string contained in the
   ibmSPEMNodeIndepVarSBSFormat object.”
  ::= { ibmSPEMNodeIndepVarEntry 5 }

 ibmSPEMNodeIndepVarSBSFormat OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “If the ibmSPEMNodeIndepVarDataType object with the corresponding
   instance id has a value of SBS, then this object describes the
   structured fields within the variable. Included for each structured
   field is the structured field name, followed by an equal sign,
   followed by the data type for the field. The structured fields
   are defined sequentially beginning with sequence number 0.”
  ::= { ibmSPEMNodeIndepVarEntry 6 }

 ibmSPEMNodeIndepVarInitValue OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The initial value of a resource variable before it is observed
   for the first time.”
  ::= { ibmSPEMNodeIndepVarEntry 7 }

 ibmSPEMNodeIndepVarCurValueIndex OBJECT-TYPE
  SYNTAX INTEGER
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “An index into the ibmSPEMVarValuesTable table to locate value
   instances for this variable.”
  ::= { ibmSPEMNodeIndepVarEntry 8 }

 ibmSPEMNodeIndepVarClass OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The name of the class to which this resource variable belongs.”
  ::= { ibmSPEMNodeIndepVarEntry 9 }

 ibmSPEMNodeIndepVarVecElDefn OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The name(s) of instantiation vector elements associated with the
   resource variable.”
  ::= { ibmSPEMNodeIndepVarEntry 10 }

 ibmSPEMNodeIndepVarVecElDescr OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “A description of the instantiation vector elements associated with
   the resource variable.”
  ::= { ibmSPEMNodeIndepVarEntry 11 }

 ibmSPEMNodeIndepVarPTXName OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The name used to read and write the resource variable in the PTX
   shared memory.”
  ::= { ibmSPEMNodeIndepVarEntry 12 }

 ibmSPEMNodeIndepVarDefPred OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The default predicate to be applied to the resource variable.”
  ::= { ibmSPEMNodeIndepVarEntry 13 }

 ibmSPEMNodeIndepVarEventDescr OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “A description of the event generated by the application of the
   default predicate.”
  ::= { ibmSPEMNodeIndepVarEntry 14 }

 ibmSPEMNodeIndepVarOrderGroup OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The name of an Availability group. All events generated by the
   default predicates of resource variables within this order group
   name are guaranteed ordered delivery with respect to one
   another.”
  ::= { ibmSPEMNodeIndepVarEntry 15 }

 ibmSPEMVarValuesTable OBJECT-TYPE
  SYNTAX SEQUENCE OF IbmSPEMVarValuesEntry
  ACCESS  not-accessible
  STATUS mandatory
  DESCRIPTION
   “A table of current EM Variable values. Variables.”
  ::= { ibmSPEMVariables 4 }

 ibmSPEMVarValuesEntry OBJECT-TYPE
  SYNTAX IbmSPEMVarValuesEntry
  ACCESS  not-accessible
  STATUS mandatory
  DESCRIPTION
   "The current value of an event manager variable instantiation.
   The value of the ibmSPEMVarValueIndex is assigned when the
   SP sub-agent (sp_configd) is initialized; it is contained in the
   ibmSPEMNodeDepVarCurValueIndex object within the ibmSPNodeDepVarsTable
   (if the variable is node-dependent) or in the
   ibmSPEMNodeIndepVarCurValueIndex object within the
   ibmSPEMNodeIndepVarTable (if the variable is node-independent).
   Each octet of the variable-length ibmSPEMVarValueInstanceVector value
   string is encoded in a separate sub-identifier, preceded by its
   length which may be 0 if its value is null. A 0 length indicates
   the function represented by the EM variable is not being monitored."
  INDEX { ibmSPEMVarValueIndex, ibmSPEMVarValueInstanceVector }
  ::= { ibmSPEMVarValuesTable 1 }

 IbmSPEMVarValuesEntry ::=
  SEQUENCE {
   ibmSPEMVarValueIndex
    INTEGER,
   ibmSPEMVarValueInstanceVector
    DisplayString,
   ibmSPEMVarValuePartaddr
    IpAddress,
   ibmSPEMVarValueName
    DisplayString,
   ibmSPEMVarValue
    DisplayString
   }

 ibmSPEMVarValueIndex OBJECT-TYPE
  SYNTAX INTEGER
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   "An index used as part of the instance id to identify the
   object instance containing the current value of an EM
   resource variable instance "
  ::= { ibmSPEMVarValuesEntry 1}

 ibmSPEMVarValueInstanceVector OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   "The instantiation vector elements associated with the
   resource variable."
  ::= { ibmSPEMVarValuesEntry 2}

 ibmSPEMVarValuePartaddr OBJECT-TYPE
  SYNTAX IpAddress
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “ip address assigned to the system partition in which the
   this resource variable resides.”
  ::= { ibmSPEMVarValuesEntry 3}

 ibmSPEMVarValueName OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “A resource variable name as defined to the Event Manager.”
  ::= { ibmSPEMVarValuesEntry 4}

 ibmSPEMVarValue OBJECT-TYPE
  SYNTAX DisplayString
  ACCESS  read-only
  STATUS mandatory
  DESCRIPTION
   “The current value of a resource variable.”
  ::= { ibmSPEMVarValuesEntry 5}

 END
```

Appendix D. Listing SP System Resource Variables

As described in Chapter 26, “The Event Management Subsystem” on page 377, the PSSP software includes a number of resource monitors that collect resource data and send it to the Event Management subsystem. You can also install resource monitors that:

- Are supplied by other IBM products or third parties.
- Have been written by programmers at your installation.

Once all of these resource monitors are running, you might want to determine what resource data is being collected in the system.

There are several ways to do this:

- You can look in the load list files that contain the Event Management configuration data for each of the resource monitors in your system.

  These files contain the data that is loaded into the SDR as Event Management objects by the **haemloadcfg** command.
- You can use commands.

  You can use the PSSP **SDRGetObjects** command to list Event Management objects that have been stored in the SDR. You can use the AIX **dspmsg** and **dspcat** commands to list individual messages and the contents of message catalogs that contain descriptions of resource variables.
- You can use the SP Perspectives graphical user interface.

  You can use the Event Perspective portion of SP Perspectives to list information about the resource variables and instance vectors that have been defined in the system.

Note that there are no Event Management resource variables for dependent nodes.

Looking at the Event Management Load List Files

The load list file for the resource variables supplied by PSSP is the **/usr/lpp/ssp/install/config/haemloadlist** file. This file is a plain text file that consists of stanzas, each of which describes an object in one of the Event Management SDR classes. For detailed information about the format of a load list file, see the man page for the **haemloadlist** file in *PSSP Command and Technical Reference*.

If you have installed other resource monitors, look at the load list files that contain their configuration data.

Getting Information about Event Management Objects in the SDR

To get information about all of the event management objects in the SDR, you can issue the **SDRGetObjects** command for each class of objects. You can also direct the output to a file, which you can then view or print. To do this, enter the following commands:

```
SDRGetObjects -G EM_Resource_Variable > rv_data
SDRGetObjects -G EM_Resource_Class > class_data
SDRGetObjects -G EM_Structured_Byte_String > sbs_data
SDRGetObjects -G EM_Instance_Vector > iv_data
SDRGetObjects -G EM_Resource_Monitor > rm_data
```

Specifying the **-G** flag ensures that you receive information about all of the resource variables in all of the system partitions in the SP system. If you are only interested in the resource variables in the current system partition, omit the **-G** flag.

Figure 44 on page 533 contains an example of the output of each **SDRGetObjects** command for the **IBM.PSSP.SP_HW.Node.lcd1** resource variable and its associated resource class, structured byte string, instance vector, and resource monitor definitions. For ease of presentation, the output has been reformatted vertically. The actual output of the command is horizontally formatted.

For a complete description of the attributes of Event Management SDR classes, see *RSCT: Event Management Programming Guide and Reference*.

You can also restrict the information you receive. For example, to get only the **rvName** and **rvClass** information for the **IBM.PSSP.SP_HW.Node.lcd1** resource variable, enter:

```
SDRGetObjects -G EM_Resource_Variable \
    rvName==IBM.PSSP.SP_HW.Node.lcd1 rvName rvClass
```

In response, the system displays:

```
rvName                            rvClass
IBM.PSSP.SP_HW.Node.lcd1          IBM.PSSP.SP_HW
```

For more information about the **SDRGetObjects** command, see *PSSP Command and Technical Reference*.

Information from **EM_Resource_Variable** class for resource variable **IBM.PSSP.SP_HW.Node.lcd1**:

```
rvName                 IBM.PSSP.SP_HW.Node.lcd1
rvDescription          244
rvValue_type           State
rvData_type            SBS
rvInitial_value        0
rvClass                IBM.PSSP.SP_HW
rvPTX_name             ""
rvPTX_description      ""
rvPTX_min              ""
rvPTX_max              ""
rvPredicate            ""
rvEvent_description    ""
rvLocator              ""
rvOrder_group          ""
rvDynamic_instance     0
rvIndex_vector         NodeNum
```

Information from **EM_Resource_Class** class for resource class **IBM.PSSP.SP_HW**:

```
rcClass                 IBM.PSSP.SP_HW
rcResource_monitor      IBM.PSSP.hmrmd
rcObservation_interval  0
rcReporting_interval    0
```

Information from **EM_Structured_Byte_String** class for resource variable **IBM.PSSP.SP_HW.Node.lcd1**:

```
sbsVariable_name       IBM.PSSP.SP_HW.Node.lcd1
sbsField_name          STRING
sbsField_type          cstring
sbsField_SN            0
sbsField_init_val       ""
```

Information from **EM_Instance_Vector** class for resource name **IBM.PSSP.SP_HW.Node**:

```
ivResource_name         IBM.PSSP.SP_HW.Node
ivElement_name          NodeNum
ivElement_description   256
```

Information from **EM_Resource_Monitor** class for resource monitor **IBM.PSSP.hmrmd**:

```
rmName                  IBM.PSSP.hmrmd
rmPath                  /usr/lpp/ssp/bin/haemRM/hmrmd
rmArguments             IBM.PSSP.hmrmd
rmMessage_file          hmrmd_des.cat
rmMessage_set           1
rmConnect_type          server
rmPTX_prefix            0
rmPTX_description       0
rmPTX_asnno             0
```

Figure 44. Sample Output from PSSP SDRGetObjects commands

Displaying Event Management Descriptions

As shown in Figure 44 on page 533, the description of resource variable **IBM.PSSP.SP_HW.Node.lcd1** is message number 244 of message set 1 of the **hmrmd_des.cat** message catalog.

To display the description, enter:

```
dspmsg -s 1 hmrmd_des.cat 244
```

In response, the system displays:

```
"(string) lcd1: 'LCD line 1'."
```

To list all of the messages in the catalog and direct the output to a file, enter:

```
dspcat hmrmd_des.cat > hmrmdcat
```

For more information on the AIX **dspmsg** and **dspcat** commands, see *AIX Commands Reference*.

Getting Resource Variable Information from SP Perspectives

You can use the SP Event Perspective to get information about the resource variables that have been defined in the system. To do this:

- Start the Event Perspective

  Enter:

  ```
  spevent &
  ```

  If you have more than one system partition defined, click on the icon that represents the system partition in which you are interested.

- Open the Create Condition dialog box.

  From the Menu bar of the Event Perspective, click on the Actions button and, from the cascading menus, select Event Definitions and then Create. In response, the system displays a notebook that is open to the Create Event Definition page.

  On the Create Event Definition page, click on the Create Condition button. In response, the system displays the Create Condition dialog box.

- Click the down arrow next to the Resource Variable Name field. In response, the system displays a list of all of the resource variables that are defined in the system partition you selected.

  To get information about any particular resource variable, select it. In response, the system displays the resource variable's name in the Resource Variable Name field, its description in the Resource Variable Description field, and the format of the instance vector in the Resource Identifier Format field.

For complete information on the Event Perspective, see the online help.

Appendix E. The System Data Repository

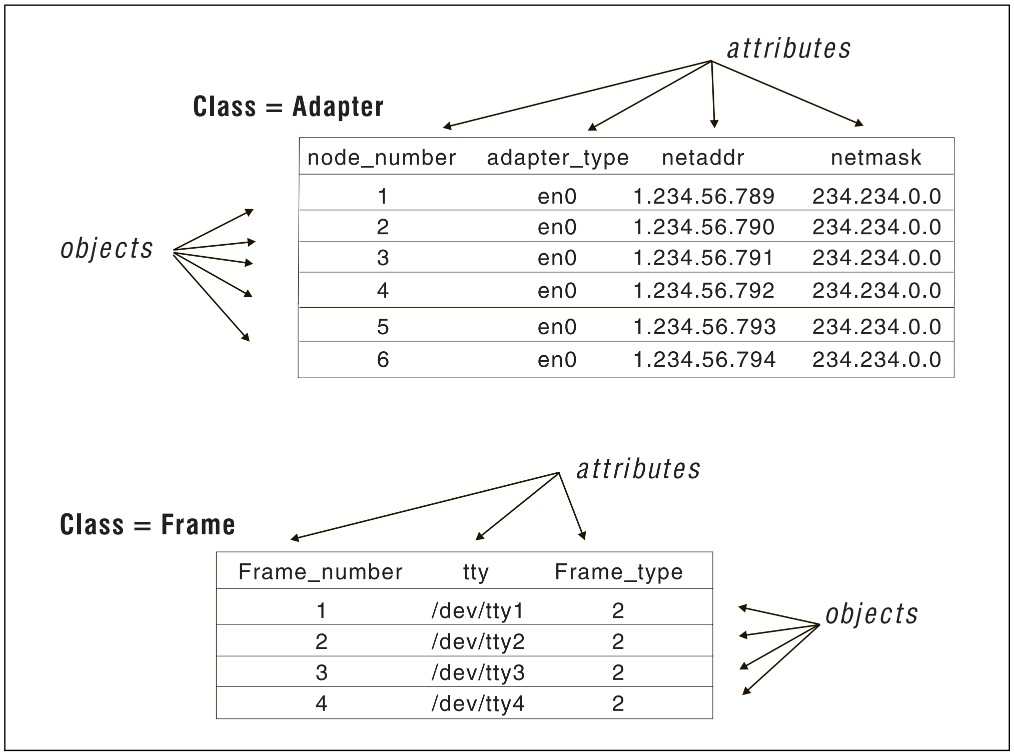
The System Data Repository (SDR) is where your SP system configuration is stored. Information entered through the SMIT panels during installation goes into the SDR. Much of the information in the SDR can be viewed and some can be entered or changed using SP Perspectives or PSSP commands.

Understanding the SDR

The SDR is composed of objects and their attributes. Objects differ according to class. For example, an object belonging to the node class has a different set of attributes from an object in the adapter class.

Objects are *instances* of the object class. Some classes have many more objects than others. For example, there is only one object in the SP class for each SP system, but there are as many objects in the node class as there are nodes in the system.

An SDR object, however, is really only a specific set of attributes. Object attributes contain the meaningful data. To illustrate, Figure 45 compares two object classes in a sample configuration, the Frame class and the Adapter class.



node_number	adapter_type	netaddr	netmask
1	en0	1.234.56.789	234.234.0.0
2	en0	1.234.56.790	234.234.0.0
3	en0	1.234.56.791	234.234.0.0
4	en0	1.234.56.792	234.234.0.0
5	en0	1.234.56.793	234.234.0.0
6	en0	1.234.56.794	234.234.0.0

Frame_number	tty	Frame_type
1	/dev/tty1	2
2	/dev/tty2	2
3	/dev/tty3	2
4	/dev/tty4	2

Figure 45. Comparing Two SDR Classes

The SP system provides *system partitioning* as a method for organizing the system into groups of nodes for various purposes such as testing new software and creating multiple production environments. Therefore there are two types of SDR classes: system and partitioned.

- System classes (contain objects that are common to all system partitions)

- Class = NodeControl
- Class = NodeExpansion
- Class = Frame
- Class = SP
- Class = SP_ports
- Class = Switch
- Class = SysNodeGroup
- Class = Syspar_map
- Class = TaskGuide

- Partitioned classes (contain objects that are specific to a system partition. The *definition* of a Partitioned class is common to all system partitions, but each system partition contains different objects for the class.)
  - Class = Adapter
  - Class = DependentAdapter
  - Class = DependentNode
  - Class = EM_Condition
  - Class = GMT_Global_smt_nds
  - Class = GS_Config
  - Class = host_responds
  - Class = HSD_Minor_Number
  - Class = HSD_Table
  - Class = Network
  - Class = Node
  - Class = pmanrmdConfig
  - Class = PMAN_Subscription
  - Class = ProcessorExtensionNode
  - Class = RVSD_Restrict_Level
  - Class = SPDM
  - Class = SPDM_Nodes
  - Class = Subset
  - Class = Switch_adapter_port
  - Class = Switch_responds
  - Class = Switch_partition
  - Class = Switch_plane
  - Class = Syspar
  - Class = Syspar_ports
  - Class = Tec_Agent_Class
  - Class = TS_Config

  - Class = TS_Tunable
  - Class = Volume_Group
  - Class = VSD_Cluster_Info
  - Class = VSD_Fence
  - Class = VSD_Global_Volume_Group
  - Class = VSD_Minor_Number
  - Class = VSD_Table

For a complete list of attributes for each object, see “System Data Repository Classes and Attributes” on page 545.

In addition, there is a set of partitioned classes that are used by Event Management application programs:

- Class = EM_Resource_Variable
- Class = EM_Structured_Byte_String
- Class = EM_Resource_ID
- Class = EM_Resource_Class
- Class = EM_Resource_Monitor

For more information about these classes and their attributes, see *RSCT: Event Management Programming Guide and Reference*.

Accessing the SDR

You can access information in the SDR by using SP Perspectives, SMIT panels, or the SDR command line interface. The SDR command line interface is used by SP Perspectives, SMIT, and various other SP commands. You do not need to use the SDR commands directly unless you are instructed to by an IBM service representative. Many system management commands, such as **spbootins**, manipulate SDR data. You must be authorized to access the SDR. The SDR performs authentication before allowing read-write access.

Authentication

The SDR handles authentication differently depending on whether DCE is being used as an authentication method. Since authentication methods are enabled on an SP system partition basis, if DCE is being used by the SDR server, the sdrd daemon running in an SP system partition, then authentication is done using DCE. If DCE is not in use by sdrd, authentication is done as before PSSP 3.2: you must be the root user on the control workstation or an SP node. An SP node is specifically one that has a connecting adapter defined in an SDR Adapter class object. When not using DCE authentication, a node can only write to partition-sensitive classes within the partition or to system classes.

To support coexistence with earlier levels of PSSP software, DCE authentication is not used when the compatibility authentication method is enabled for SP trusted services or when no authentication method is set. That means during a system migration, the SDR is no less secure than in a system without DCE and will be no more secure until after DCE is enabled on the control workstations and all the nodes.

Authorization

On systems that do not use DCE, the SDR has two levels of authorization: read-write and read-only. On systems using DCE the SDR has three levels of authorization: read-only, read-write, and read-write-admin. Commands issued without the necessary authorization will fail.

Table 19 shows the conditions under which each level of authorization is given on a system not using DCE.

Table 19. SDR Authorizations on a System without DCE

Machine	Root User	Non-Root User
Control Workstation	read-write	read-only
SP Node	read-write	read-only
Other	read-only	read-only

On DCE systems, anyone is allowed to read the SDR. Write and admin access is authorized by membership in eight DCE groups. The admin authority includes write authority as well. There are separate access groups for system classes and for partition-sensitive classes. There are user access groups to which a security administrator can add user principals and there are service access groups that are for the SP trusted services. The groups are the following:

ssp/sdr-admin user group for partition-sensitive classes

ssp/sdr-write user group for partition-sensitive classes

ssp/sdr-admin-services services group for partition-sensitive classes

ssp/sdr-write-services services group for partition-sensitive classes

ssp/sdr-system-class-admin user group for system classes

ssp/sdr-system-class-write user group for system classes

ssp/sdr-system-class-admin-services services group for system classes

ssp/sdr-system-class-write-services services group for system classes

Only partition-sensitive classes are defined as being partitionable in the **spsec_defaults** configuration file. To have a separate group for each partition, you can define the **:p** option for the group in the **spsec_overrides** file.

The SDR commands that require write permission are the following:

SDRChangeAttrValues
SDRCreateObjects
SDRDeleteObjects
SDRMoveObjects
SDRReplaceFile

The SDR commands that require admin permission are the following:

SDRClearLock
SDRCreateClass
SDRCreateFile
SDRDeleteFile
SDRCreateSystemClass

SDRCreateSystemFile
SDRDeleteSystemFile

If a partition has both DCE and compatibility authentication set for SP trusted services, root users on the SP will be able to do SDR write and admin operations. Also, anyone with DCE credentials that are in one or more DCE SDR access groups will be able to do SDR write and admin operations.

Locating the SDR Server

There are three ways in which a process can locate the SDR server. They are selected in the following order of preference but when one method is selected, no other methods are attempted. This means that if method 1 is available, only method 1 is attempted. If it fails, methods 2 and 3 are *not* attempted.

1. The destination is passed as the third parameter in the **SDROpenSession** command. This only works for library routines and therefore may be used by some SP subsystems, such as the Resource Manager. The destination is the hostname or TCP/IP address of the control workstation where the SDR runs.
2. The **SP_NAME** environment variable is set to the hostname or TCP/IP address of the control workstation where the SDR runs.
3. The **/etc/SDR_dest_info** file is present and has the **primary** record set to the hostname or TCP/IP address of the control workstation where the SDR runs. This file is installed on the control workstation and all SP system nodes along with the PSSP software.

The SDR_dest_info File

The **/etc/SDR_dest_info** file is created on the control workstation at system installation, and propagated to all nodes in the SP system. The **/etc/SDR_dest_info** file has the following format:

```
* comments have an asterisk in column 1
default: <TCP/IP address of default system partition>
primary: <TCP/IP address of node's partition>
nameofdefault: <hostname of default system partition>
nameofprimary: <hostname of name of the node's partition>
```

The **default** record identifies the default system partition. The default record is used at boot time so that the node can determine if it has changed system partitions.

Only the **primary** record is used by the SDR to locate the control workstation where the SDR server runs.

The SDR Daemon Log

The SDR daemon writes information to a log named **/var/adm/SPlogs/sdr/sdrdlog.***syspar_ip_addr.pid*, where *syspar_ip_addr* is the IP address of the system partition and *pid* is the process ID of the SDR daemon (**sdrd** process). This log will contain the date and time the process started, as well as problems encountered by the daemon in the course of operation.

Method 1 – Using SMIT

The RS/6000 SP System Management SMIT panel provides options for accessing configuration data in the SDR. To invoke this panel:

TYPE **smit**

- The System Management menu appears.

SELECT **RS/6000 SP System Management**

- The RS/6000 SP System Management menu appears.

The RS/6000 SP System Management menu offers the following options:

1. RS/6000 SP Configuration Database Management

   The dialogs available through this path allow you to enter, list, and change information during the installation process about your nodes, primary and secondary external LANs, and switch connections, as well as site environment information. These tasks are explained in the *PSSP: Installation and Migration Guide*.

   The choices from this menu are:

   - *Enter Database Information*
     - *Site Environment Information*
     - *Frame Information*
     - *Node Database Information*
     - *Node Group Information*
     - *System Partition Configuration*
     - *Extension Node Database Information*
     - *Run setup_server Command*
   - *List Database Information*
     - *List Site Environment Database Information*
     - *List Frame Database Information*
     - *List Node Database Information*
       - *List Node Configuration Information*
       - *List Node Switch Information*
       - *List Node Boot/Install Information*
       - *List Volume Group Information*
       - *List Node Expansion Information*
       - *List Accounting Information*
     - *List Node Group Database Information*
     - *List System Partition Database Information*
     - *List LAN Database Information*
     - *List Extension Node Database Information*
     - *List Extension Node Adapters Database Information*
   - *Delete Database Information*
     - *Delete Frame Information*
     - *Delete Node Information*
     - *Delete Volume Group Information*
     - *Delete Adapter Information*
     - *Delete Node Expansion Information*
     - *Delete Node Group Information*
     - *Delete Extension Node Information*

   - *Delete Extension Node Adapter Information*

2. RS/6000 SP Cluster Management

   The choices from this menu are:

   - *Run setup_server Command*
   - *Select System Tuning Parameters*
   - *Perform Switch Operations*
   - *Run enadmin Command*

3. RS/6000 SP Configuration Information

   Using this path, you can display configuration information about your nodes, networks, file systems, and paging spaces.

   The choices from this menu are:

   - *List Node Hardware Information*
   - *List Node Network Information*
   - *List Node File System Information*

4. RS/6000 SP Users

   Using this path, you can add and delete users, as well as change user management attributes such as passwords.

   The choices from this menu are:

   - *Add a User*
   - *Change/Show Characteristics of a User*
   - *Remove a User*

5. RS/6000 SP Installation/Configuration Verification

   Use this path to check that your PSSP software options are installed correctly.

   The choices are:

   - *System Monitor Installation*
   - *System Monitor Configuration*
   - *System Data Repository*
   - *System Management*
   - *Communication Subsystem*
   - *System Partition Configuration*
   - *Switch Table API Installation*
   - *Resource Manager Installation*
   - *Resource Manager Configuration*

6. RS/6000 SP Supervisor Manager

   The choices are:

   - *Check for Supervisors That Require Action (Single Message Issued)*
   - *List Status of Supervisors (Report Form)*
   - *List Status of Supervisors (Matrix Form)*
   - *List Supervisors That Require Action (Report Form)*
   - *List Supervisors That Require Action (Matrix Form)*
   - *Update *ALL* Supervisors That Require Action (Use Most Current Level)*
   - *Update Selectable Supervisors That Require Action (Use Most Current Level)*

7. RS/6000 SP Resource Manager

   The choices are:

- *Change/Show Configuration Data*
- *Start the Resource Manager*
- *Reconfigure the Resource Manager*
- *Stop the Resource Manager*

8. RS/6000 SP Log Management

   The choices are:

   - *AIX Error Log*
   - *Syslog*
   - *General Log Viewing*
   - *Archive Logs*
   - *Collect Logs for Service*

The menu selections run standard AIX commands and, in some cases, add information from the Hardware Monitor and reformat the output for usability. Let's examine the options on the list menu in more detail. The Configuration Information menu contains options that invoke the AIX commands listed in Table 20.

Table 20. Commands Invoked by SMIT Panels

Select:	**To:**
List Node Hardware Information	Run the AIX **lscfg** command to display the name, location, and description of the devices related to the nodes
List Node Network Information	Run the AIX **netstat -in** command to show the state of the nodes' configured interfaces
List Node File System Information	Run the AIX **df** command to display the total spaces and available space on the node file systems

SELECT Any of the three choices

- SMIT runs the corresponding AIX command for all the nodes and displays the information in a scrollable window.

You can also list the configuration data using the **splstdata** command. See the book *PSSP: Command and Technical Reference* for complete syntax and examples.

Method 2 – Using the SDR Command Line Interface

A command line interface allows you to display, change, or delete the contents of an SDR object without invoking SMIT panels.

These commands are used by the PSSP components to operate on SDR data. You should not need to use these commands directly. Should you choose to use them, do so with caution. SDR contents can be corrupted or made inaccessible.

The following list briefly describes these commands. See the book *PSSP: Command and Technical Reference* for exact syntax.

SDRAddSyspar
The PSSP components use this command to create a new daemon using the System Resource Controller (SRC).

SDRArchive
The PSSP components use this command to create an archives file containing all current SDR classes attributes.

SDRChangeAttrValues
The PSSP components use this command to change the attribute values of an existing object.

SDRClearLock
The PSSP components use this command to unlock a class that is locked, regardless of who has the lock. This is for system administration use only and should be used with caution.

SDRCreateAttrs
The PSSP components use this command to create new attributes for an SDR class.

SDRCreateClass
The PSSP components use this command to create a new class of objects and its attributes.

SDRCreateFile
The PSSP components use this command to create an SDR file from an AIX file.

SDRCreateObjects
The PSSP components use this command to create one or more new objects and define their attribute values.

SDRCreateSystemClass
The PSSP components use this command to create a system class.

SDRCreateSystemFile
The PSSP components use this command to create a file that can be retrieved from any system partition.

SDRDeleteFile
The PSSP components use this command to delete an SDR file.

SDRDeleteObjects
The PSSP components use this command to delete target objects.

SDRGetObjects
The PSSP components use this command to query the values of target objects and attributes and prints them to stdout.

SDRListClasses
The PSSP components use this command to list the class names in the SDR.

SDRListFiles
The PSSP components use this command to first list all the files in the system area, then list all the files in the system partition area.

SDRMoveObjects
The PSSP components use this command to move objects from one system partition to another.

SDRRemoveSyspar
The PSSP components use this command to remove the entire contents of the subdirectory under system partitions. It uses the SRC to remove the daemon that serves the system partition.

SDRReplaceFile
The PSSP components use this command to replace the specified SDR file with the specified AIX file.

SDRRestore
The PSSP components use this command to overwrite the current SDR with the contents of an archived SDR file.

SDRRetrieveFile
The PSSP components use this command to create an AIX file from an SDR file.

SDR_test
The PSSP components use this command to verify that the installation and configuration of the SDR completed successfully.

SDRWhoHasLock
The PSSP components use this command to query the lock transaction ID for a specified object class.

Updating the host_responds Class (the hrd Daemon)

The **host_responds** class in the SDR is updated automatically by the **hrd** daemon. The **hrd** daemon is called from the **hr** script, which is under SRC control. **hr** will respawn if it, or the **hrd** daemon, is killed. **hr** and **hrd** run on the control workstation. Both the **hr** script and the **hrd** daemon are in directory **/usr/lpp/ssp/bin**. (The **hrctrl** script provides the same function as the **hr** script, but it follows the syntax of the **syspar_ctrl** command.)

The **hrd** daemon monitors the SP nodes using the Event Management subsystem. The **hrd** daemon acts as an Event Management client on the control workstation, using the EMAPI to subscribe for events pertaining to the IBM.PSSP.Membership.LANAdapter.state resource variables for the SP ethernet adapter on each node. Event Management notifies the **hrd** daemon when a node's adapters comes up or goes down and **hrd** updates the node's **host_responds** variable based on this value. For example, **host_reponds**is set to 1 when its SP ethernet adapter is reported as up and is set to 0 when its SP Ethernet adapter is reported as down.

The second method by which **hrd** can get node status is to use **fping**. **fping** is a program that runs **ping** to many nodes asynchronously. This second method also issues **snmpinfo** calls to each node, to detect a situation where **ping** succeeds but the node is not responding to user requests.

The **hr** script determines which method will be used. An environment variable named `HR_FPING` is set to **0** for heartbeat or **1** for **fping**. The default is **0**.

The line that chooses between the methods looks like this:

```
typeset -x HR_FPING=0
```

After making a change to this file, you should reset the **hrd** daemon by issuing **hr reset**. This will cause it to respawn and the change will be put in effect. Other options for configuring **hrd** are documented in comments in the **hr** script (in **/usr/lpp/ssp/bin**).

The reason for the second method (**fping**) is that it has different characteristics than the system heartbeat. It does not require a daemon to be on each node, so it may reduce cpu usage on the nodes by a small amount.

Backing Up the SDR

Backing up the SDR regularly is a good way to insure against the loss of your data. Whenever you change your SP system configuration, use the **SDRArchive** command to take a snapshot of the SDR contents and save it in a **tar** file. The *PSSP: Command and Technical Reference* contains syntax and usage information.

You can restore a saved image of the SDR using the **SDRRestore** command. Before restoring the SDR, be sure to stop the Resource Manager. (Refer to Chapter 15, “Using Job Switch Resource Table Services” on page 245.)

SDR Shadow Files

The SDR classes are stored in subdirectories under directory **/spdata/sys1/sdr**. The subdirectories of interest are **/system/classes** and **/partitions/***partition_ip_address***/classes**. The names of the files in those directories correspond to the names of the classes.

Before SDR commits changes to a class, the class contents are moved to a backup file in the same directory as the class. The backup file is named *class*.**shadow**, where *class* is the name of the class being written. If a power loss occurs or the SDR daemon is killed while the SDR class is being written, the class file that was being written at the time may not exist or may be corrupted. You should check for the existence of a *class*.**shadow** file. If one exists, take the following steps to restore the class.

1. Remove the corrupted *class* file (if one exists).
2. Rename the *class*.**shadow** file to *class*.
3. Restart the SDR daemon (**sdrd**) by issuing **sdr reset**.

The SDR daemon will restart automatically and recognize the renamed shadow file as the class.

System Data Repository Classes and Attributes

The following tables list all the SDR classes. You can specify these classes as targets in **SDRxxxxx** commands. The value in the **Type** column is the data type of the attribute: S=string, I=integer, F=floating point.

Class = Adapter

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Relative node number	

Attribute Name	*Type*	*Description*	*Comments*
adapter_type	S	Adapter type as recorded in ODM (lsp0, enet0, enet1, fi0, fi1 etc.)	Set via customer through CMI. Only en0 is required.
netaddr	S	ip address for this interface.	Set via customer through CMI.
netmask	S	netmask for this interface.	Set via customer through CMI.
tok_rate	I	Speed of token rate, (4 or 16 mb)	
enet_type	S	bnc, dix, fiber, tp, or NA	
ucode_version	S	The file name of the microcode that is loaded	
prog_logic_version	S	Programmable logic	Currently not used
other_addrs	S	Alias IP addresses	Used by HACMP
subnet	S	Subnet for the adapter	
enet_rate	S	Ethernet adapter rate (10, 100, 1000, or auto)	10Mb/s, 100Mb/s, 1000Mb/s, or autosense
duplex	S	Ethernet adapter duplex (full, half, or auto)	Full duplex, half duplex, or autosense
css_type	S	The external switch adapter name	Possible values: SP_Switch_Adapter SP_Switch_MX_Adapter SP_Switch_MX2_Adapter RS/6000_SP_System_Attachment_Adapter SP_Switch2_Adapter
adapter_config_status	S	Status of the switch adapter in the node for SP Switch2 systems only	Status can be one of css_ready, diag_fail, microcode_load_fail, or not_configured. Filled in during rc.switch processing.

Class = DependentAdapter

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Relative node number for the dependent node.	Set by the -r flag on the **endefadapter** command.
netaddr	S	IP address for this interface.	Set by the -a flag on the **endefadapter** command.

Attribute Name	*Type*	*Description*	*Comments*
netmask	S	IP netmask for this interface.	Set by the -m flag on the **endefadapter** command.

Class = DependentNode

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Represents the relative node number for the dependent node.	This is set by the **-n** flag of the **endefnode** command.
switch_node_number	I	Represents the switch port to which the dependent node is connected.	
switch_chip_port	I	Represents the number of the switch chip port to which the dependent node is connected.	
switch_chip	I	Represents the number of the switch chip to which the dependent node is connected.	
switch_number	I	Represents the switch board to which the dependent node is connected.	
switch_partition_number	I	Represents the number of the switch partition for this dependent node.	
reliable_hostname	S	Represents the host name associated with the dependent nodes network interface on the administrative network.	This is specified by the **-a** flag on the **endefnode** command.
management_agent_hostname	S	Represents the host name of the dependent node's SNMP Agent that interacts with the SNMP Manager on the SP. This host name must resolve to an IP address.	This is specified by the **-s** flag of the **endefnode** command. May be the same as or different from the **reliable_hostname**, depending on the characteristics of the extension node.

Attribute Name	*Type*	*Description*	*Comments*
extension_node_identifier	S	A unique identifier in the administrative environment of an extension node. For example, for the Ascend GRF switched IP router, the slot number of the SP Switch Router Adapter on the GRF.	This is set by the **-i** flag of the **endefnode** command.
snmp_community_name	S	Represents the SNMP community name for the authentication field in the SNMP messages exchanged between the SNMP Agent on the dependent node and the SNMP Manager on the SP	This is specified by the **-c** flag of the **endefnode** command.

Class = EM_Condition

Attribute Name	*Type*	*Description*	*Comments*
name	S	The name of this condition	
variable	S	The resource variable name to which this condition applies	
predicate	S	The condition	
rearm	S	The rearm condition	
specified	S	The specified resource ID elements	
unspecified	S	The unspecified resource ID elements	
description	S	A description of this condition	

type	S	Indicates if this condition is a default condition.
		default = default condition
		blank = a user-created condition	

Class = Frame

Attribute Name	*Type*	*Description*	*Comments*
frame_number	I	Frame number	Assigned with the spframe command.
s1_tty	S	The tty port used for serial (s1term) communications.	A new attribute for S70 nodes assigned with the spframe command. It is undefined for SP frames.
tty	S	The tty port to be used for this frame (like /dev/tty1)	Assigned with the spframe command.
hardware_protocol	S	Type of hardware to be controlled: SP, SAMI.	Assigned with the spframe command. For S70 nodes, SAMI. The default is SP.
frame_type	S	Type of frame: Switch, no switch, all switch, or non-node.	From information returned by the monitor. For an SP Expansion I/O Unit the value is non-node. For SP-attached servers, this value is undefined.
MACN	S	Stands for Monitor and Control Node.	Hostname of the machine that monitors this frame.
backup_MACN	S	The backup monitor and control node for hardware monitoring with High Availability Control Workstation Connectivity function.	
slots	I	The number of slots in the frame.	A full-size frame is 79 inches (2.00 meters) and contains 16 slots. An SP Switch-8 frame is 49 inches (1.25 meters) and contains 8 slots. In a SP-attached server frame, this value is 1.
frame_in_config	I	Relative position of frame within expansion frame configuration (1,2,3,4).	In a SP-attached server frame, this value is undefined.
snn_index	I	Internal attribute used to index to determine correct switch node numbers.	In an SP-attached server frame, the value is undefined (it cannot contain a switch).
switch_config	I	Internal attribute used to determine switch configuration.	In an SP-attached server frame, this value is undefined (it cannot contain a switch).

Class = GMT_Global_smt_nds

Attribute Name	*Type*	*Description*	*Comments*
node_1	I	Global Mount uses this node as primary smart node.	
node_2	I	Global Mount uses this node as backup smart node.	
node_3	I	Global Mount uses this node as backup smart node.	
node_4	I	Global Mount uses this node as backup smart node.	
node_5	I	Global Mount uses this node as backup smart node.	

Class = GS_Config

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	The node number	
gs_release_level	I	The Group Services release that the node is running	

Class = host_responds

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Relative node number	This attribute gets mapped to frame/slot to retrieve DE value
host_responds	I	0 or 1 to indicate host is down or up.	This is really a query into the frame info written by the System Monitor.

Class = HSD_Minor_Number

Attribute Name	*Type*	*Description*	*Comments*
minor_number	I	Unique minor numbers	

Class = HSD_Table

Attribute Name	*Type*	*Description*	*Comments*
minor_number	I	Unique minor numbers	
stripe_size	I	Stripe width	
num_vsds	I	Number of vsds in a hsd.	
option	S	Whether the hsd will skip the first stripe on each underlying vsd in an hsd.	Value is **protect_lvcb** or **not_protect_lvcb**
HSD_name	S	Name of the hsd.	
VSD_name	S	Name of the vsd.	
size_in_MB	I	Size of table.	

Class = Network

Attribute Name	*Type*	*Description*	*Comments*
networkName	S		Not currently filled.
networkType	S	The type of network. For example, FDDI, token ring, ATM, ethernet.	Not currently filled.
hbInterval	I	Heartbeat send frequency, in seconds, for this type of network. This overrides the value set in the TS_Tunable class.	
hbTolerance	I	Number of heartbeats from the neighboring node that can be missed before the neighbor is declared inoperative. This overrides the value set in the TS_Tunable class.	

Attribute Name	*Type*	*Description*	*Comments*
hbEnable	I	Specified whether Topology Services should use this network for heartbeating. 1 = network should be used 0 = network should not be used	
VSD_name	S	Name of the vsd.	
size_in_MB	I	Size of table.	

Class = Node

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Relative node number ((frame#-1)*16)+slot.	This number is computed from frame information and put here by system management.
hdw_enet_addr	I	Universal hardware ethernet identifier for this node.	Obtained through the system monitor during system initialization.
frame_number	I	Frame number.	Number from 1 to number of frames. Set during object creation.
slot_number	I	Node slot in frame.	Number from 1 to number of nodes. Set during object creation. For SP-attached server nodes, this value is set to 1.
slots_used	I	Nodes use 1, 2 or 4 slots. Distinguishes thin, wide or 604 High Node nodes.	Set by data obtained from system monitor. For SP-attached server nodes, this value is set to 1.
switch_node_number	I	Switch relative node number.	Set during object creation from data obtained from system monitor. For SP-attached server nodes, this value is set to the switch node number associated with the switch port on an existing SP frame. In a switchless system, it is assigned by the customer.

Attribute Name	*Type*	*Description*	*Comments*
switch_chip_port	I	Switch port to which this node is connected.	Set during object creation from data obtained from system monitor. On a SP-attached server node, this value is the switch port on an existing SP frame to which the SP-attached server node is connected.
switch_chip	I	Switch chip number to which this node is connected.	Set during object creation from data obtained from system monitor. On a SP-attached server node, this value is the switch chip number for the switch port to which the SP-attached server node is connected.
switch_number	I	Switch number to which this node is connected.	Set during object creation from data obtained from system monitor. On a SP-attached server node, this value is the switch number for the switch port that the SP-attached server node is connected to.
initial_hostname	S	Hostname assigned to this node during customization.	Customer supplied from CMI at installation.
reliable_hostname	S	Hostname associated with SP ethernet.	Set during CMI processing from name entered for en0 interface name.
default_route	S	IP address of default route.	Customer supplied from CMI at installation.
boot_server	I	Relative node number of node that will answer bootp request when necessary. (0 represent control workstation.)	Set during creation to be node 1 of frame. For node 1 in frame set to 0 to represent control workstation.
bootdisk	S	The disk from which the node last booted.	Set by PSSP when the node is installed or customized.
install_image	S	Path of net install image for this node. This field is initially set to **DEFAULT**, meaning that the default image is used.	Optionally set by customer from CMI interface.
install_disk	S	Same as **pv_list** in the **Volume_group** class.	Set during node creation based on the node type.

Attribute Name	*Type*	*Description*	*Comments*
last_install_time	S	Time and date that this system was last successfully installed.	Set during network installation.
last_install_image	S	server:/filepath of last image installed.	Set during network installation.
switch_protocol	S	This is the string **LSP** or **CSSCI**.	
switch_partition_number	I	Switch partition this node belongs to.	Default is **1**.
bootp_response	S	**install**=full net install and customize; **disk**=use local disk to boot (ignore bootp request); **maintenance**=on reboot, go into Installation/Maintenance menus; **customize**=just use information from SDR to customize node's ODM; **restore**=restore of backup image via network install.	Initially set to **customize** during object creation. Changeable through CMI interface.
boot_device	S	Device from which to network boot.	Set to en0.
usr_maint	S	If set to **true** a node will perform usr client maintenance on boot.	Initialized to **false**, set through CMI.
VSD_adapter	S	The adapter on this node used by the vsd.	This is an adapter type to be joined with the adapter_type attribute of the Adapter class, where the node and Adapter node_number fields match.
VSD_max_buffer_count	I	Buffer cache size for vsd.	
VSD_request_blocks	I	The number of request blocks the vsd should allocate.	This value will be ignored, but a value must be specified to support coexistence.
VSD_pbufs	I	The number of pbufs the vsd should allocate.	This value will be ignored, but a value must be specified to support coexistence.
VSD_init_buffer_count	I	Buffer cache size for vsd.	
VSD_min_buddy_buffer_size	I	The minimum vsd buddy buffer size allocated to a single request.	

Attribute Name	*Type*	*Description*	*Comments*
VSD_max_buddy_buffer_size	I	The maximum vsd buddy buffer size allocated to a single request.	
VSD_max_buddy_buffers	I	The size of the vsd buddy buffer, given in the number of buffers of max_buddy size.	
VSD_do_ip_checksum	S	Test to determine when to do IP checksum calculation.	
cfs_adapter	S	The adapter on this node used by Calypso and Global Mount.	
acct_class_id	S	An ID selected by administrator for grouping and merging acct data.	Default = **default**.
acct_enable	S	Whether acct is enabled for a node.	Default = **default**.
acct_job_charge	S	Used to determine the number of charge fee units to charge a user for exclusive use of the node. Its value is in units of "seconds per charge fee unit".	Default = **1.0**.
acct_excluse_enable	S	Indicates whether stop and end job accounting records will be generated for jobs having exclusive use of a node.	Default = **false**.
usr_server_ip	S	This is either an IP address or **local**.	Default is **local**.
usr_client_adapter	S	This will be **enX**, **trX** where X can be any number.	Default is **en0**.
has_usr_clients	S	This will be either true or false.	Default is false.
code_version	S	Contains the ssp release that is installed on this node.	Default is nothing (unknown).
usr_gateway_ip	S	The IP address of the gateway to get to **/usr** server.	Default is **0**, meaning **/usr** server is not on a gateway.

Attribute Name	*Type*	*Description*	*Comments*
VSD_maxIPmsgsz	I	Largest sized block of data that the IBM Virtual Shared Disk sends over the network for an I/O request.	Default is **61440**.
lppsource_name	S	The name of the LPP source resource from which to obtain AIX file sets for the installation of this node.	
processors_installed	I	The total number of processors in the node.	
processor_type	S	Specifies if the node is a uniprocessor or multiprocessor.	Value is **UP** or **MP**.
description	S	Provides a desciption.	
platform	S	Architecture of the node.	
hardware_control_type	S	Type of hardware control this node has.	If this node has a supervisor, this value is set to the node supervisor card type. For SP-attached server nodes, this value is set to 10 (decimal).
RVSD_version	I	Represents the RVSD version in VRMF format.	
selected_vg	S	The root volume group to install next.	Initially set to "rootvg".
dcehostname	S	Name by which DCE knows the host.	
expansion_list	S	List of *expansion_number* values from each NodeExpansion object for an expansion unit connected to this node.	Each expansion_number is separated by a comma. A null list means there are no NodeExpansion objects related to this node.

Class = NodeControl

Attribute Name	*Type*	*Description*	*Comments*
type	S	Type of node.	For SP frame nodes, this value is set to the Node supervisor card type. For SP-attached server nodes, this value is set to 10 (decimal).
capabilities	S	Comma-separated list of capabilities (no embedded blanks).	For SP frame nodes, valid values are power, reset, tty, keySwitch, LED, networkBoot. For 332 MHz SMP wide or thin nodes, valid values are power, reset, tty, LED, networkBoot. For S70 nodes, valid values are power, reset, tty, LED, networkBoot.
slots_used	I	Number of slots used by this node type.	The correct number for each type of node. For S70 nodes, the valid value is 1.
platform_type	S	Hardware platform type.	For most SP nodes, the valid value is rs6k. For 332 MHx SMP wide or thin nodes, and S70 nodes, valid value is chrp.
processor_type	S	Specifies whether this is a uni-processor or multi-processor node.	Valid values are UP or MP as appropriate for each type of node. For S70 nodes, valid value is MP.
NC_timeout	I	The timeout value used by the nodecond command.	Allow more time for SMPs and nodes with a lot of I/O capability.
def_copies	I	The default number of copies of the root volume group to create for this node type.	Total number of copies is one or two.
def_pv_list	S	A list of physical volumes to be used for the root volume group and any mirrored copies.	There must be at least one extra disk for each copy of the root volume group.
def_quorum	S	The default quorum setting for this node type.	Valid values are true and false. Set it to false when mirroring.

Class = NodeExpansion

Attribute Name	*Type*	*Description*	*Comments*
expansion_number	I	Unique SP number for this expansion unit.	Like the node_number value for a node but it is for the frame and slot location of this unit. Derived using (*frame_number*-1)*16+*slot_number*.
frame_number	I	Frame location.	Passed to hardmon by I/O Unit supervisor.
slot_number	I	Slot location.	Passed to hardmon by I/O Unit supervisor.
slots_used	I	Number of slots it occupies (1).	Taken from NodeControl table.
hardware_control_type	S	The supervisor card type (145).	Passed to hardmon by I/O Unit supervisor.
associated_node	I	Node number of node to which this is connected.	Passed to hardmon by I/O Unit supervisor (hardmon gets frame and slot numbers and converts to this node number).

Class = PMAN_Subscription

Attribute Name	*Type*	*Description*	*Comments*
pmTargetType	S	Identifies the type of the parameter in the **pmTarget** field.	**NODE_LIST**, **NODE_RANGE**, or **NODE_GROUP**.
pmTarget	S	Identifies the set of nodes on which to execute the actions that are specified by the pmCommand, pmTrapid, and pmText fields in response to events and by the pmRearmCommand, pmRearmTrapid, and pmRearmText fields in response to rearm events. This field may contain a node range, a list of hostnames, or the name of a node group.	A pre-defined node group, **ALLPMAN**, is provided. This node group consists of all the nodes in the current system partition.
pmRvar	S	Specifies the resource variable name for the event.	Required.

Attribute Name	*Type*	*Description*	*Comments*
pmIvec	S	Specifies a fully-qualified resource identifier for the event.	Required.
pmPred	S	Specifies an expression for the event.	Required.
pmCommand	S	The command to run in response to events.	Optional.
pmCommandTimeout	S	The amount of time, in seconds, to wait before assuming that the **pmCommand** has hung, and killing it.	Optional.
pmHandle	S	A label used to identify the subscription.	Required.
pmTrapid	I	An SNMP trap ID to send in response to events.	Optional.
pmPPSlog	I	Keeps track of whether the pmText field contains message text.	Optional.
pmThrottle			Not currently used.
pmRearmPred	S	Rearm expression which forms part of the event definition.	Optional.
pmRearmTrapid	I	An SNMP trap ID to send in response to rearm events.	Optional.
pmRearmPPSlog	I	Keeps track of whether the pmRearmText field contains message text.	Optional.
pmRearmCommand	S	The command to issue when the rearm event occurs.	Optional.
pmRearmCommandTimeout	S	The amount of time to wait, in seconds, before assuming the command has hung, and killing it.	Optional.
pmUsername	S	The user name of the subscriber event.	Defaults to root.
pmPrincipal	S	The Kerberos principal of the user who creates the subscription. This field establishes ownership of the subscription.	Required.

Attribute Name	*Type*	*Description*	*Comments*
pmHost	S	The hostname of the node where the users issues the pmandef command to create the subscription.	Defaults to the local node.
pmDeactivated	S	Contains either NONE, ALL, or bitmask. NONE indicates all the nodes are activated. ALL indicates that all the nodes are deactivated. bitmask indicates that the subscription contains a mixture of activated and deactivated nodes.	Default is activated.
pmText	S	Text to be written to the AIX error log and BSD syslog facilities in response to events.	Optional.
pmRearmtext	S	Text to be written to the AIX error log and BSD syslog facilities in resonse to rearm events.	Optional.
pmUserLabel	S	Stores the name of the **Named_Condition** from the Event Management subsystem, if one was used to subscribe to a problem management record.	Used by the SP Perspectives GUI.
pmInitEval	I	Specifies whether to register a user's event definition with Event Management without prompting for immediate evaluation.	A value of 0 causes pmand to register the event without prompting for immediate evaluation. -1 causes pmand to request immediate evaluation.
pmDCEPrincipal	S	Stores user's DCE principal if it exists.	
pmAIXOwner	S	Stores user's AIX user name if it's available.	This is the AIX user name of the user who creates the subscription, not the AIX user name that is used to execute commands in response to events.

Class = pmanrmdConfig

Attribute Name	*Type*	*Description*	*Comments*
pmrmNodenumber	I	The node number of the host on which **pmanrmd** is to instantiate the resource variable being defined.	
pmrmTargetType	S	Identifies the type of the parameter in the **pmTarget** field.	**NODE_LIST**, **NODE_RANGE**, or **NODE_GROUP**
pmrmTarget	S	Lists the targets on which daemons are to be configured. Can be a list of host names (**NODE_LIST**) separated by commas, a range of nodes (**NODE_RANGE**) as specified by the **-n** argument to **hostlist**, or the name of a node group (**NODE_GROUP**).	
pmrmRvar	S	Specifies the resource variable being defined.	Must be **IBM.PSSP.User_state***nn*, where *nn* is 1-16.
pmrmCommand	S	Specifies a command to run at the specified interval.	
pmrmSampInt	I	Specifies a sampling interval, in seconds, for the resource variable.	

Class = ProcessorExtensionNode

Attribute Name	*Type*	*Description*	*Comments*
hostname	S	The hostname assigned to this object during configuration.	Can be set by the **-n** flag of the **sppenode** command or using Perspectives.
short_comment	S	To identify the subject of this specific object, such as an SP-controlled Netfinity server.	Can be set by the **-s** flag of the **sppenode** command.
long_comment	S	To further identify or describe the subject or purpose of this specific object.	Can be set by the **-l** flag of the **sppenode** command.
node_number	I	The relative node number derived by ((frame#-1)*16)+1.	Is set in this class for objects such as an SP-controlled Netfinity server.

Class = RVSD_Restrict_Level

Attribute Name	*Type*	*Description*	*Comments*
domain	S		Not currently used.
level	I	Represents the functional level that RVSD will run at in VRMF format.	

Class = SP

Attribute Name	*Type*	*Description*	*Comments*
control_workstation	S	Hostname of control workstation.	
cw_ipaddrs	S	IP addresses of control workstation.	
install_image	S	Full path of net install image.	Customer supplied from CMI at installation.
remove_image	S	If set to **true** the install images are erased after all nodes have been installed from this server.	Customer supplied from CMI at installation.
primary_node	S	Ethernet hostname of primary node.	Default is node 1 frame 1.
ntp_config	S	The kind of NTP installation done: **none**=Do not configure NTP for this site. **consensus**=setup NTP to configure Control Workstation as the NTP server and boot servers as NTP peers. **timemaster**=site has an existing NTP server. Configure NTP to user these. NTP_SERVERS will contain the NTP server hostnames. **internet**=The Control Workstation has access to the internet. Configure the Control Workstation to be an NTP server using the internet time server(s) defined in NTP_SERVERS.	From customer input from CMI.
ntp_server	S	Hostname of NTP server.	From customer input from CMI.
ntp_version	S	Default is 3.	Customer can override using CMI.
amd_config	S	**True** or **False** for whether the SP will provide automounter support	Customer can input in CMI, default is false.

Attribute Name	*Type*	*Description*	*Comments*
print_config	S	**false**=do not print **secure**=install print in secure mode **open**=install print in open mode	Default is false, changed from customer via CMI.
print_id	S	User name to rsh to for secure mode printing	From customer via CMI.
usermgmt_config	S	**false**=do not install SP user management **true**=install SP user management code and SMIT interface	Default is false, changed from customer via CMI.
passwd_file	S	File containing password information (/etc/passwd, or other).	Default is /etc/passwd.
passwd_file_loc	S	Location of password file.	
homedir_server	S	Hostname of default user directory server for user management code.	From customer via CMI, default is control workstation.
homedir_path	S	Default path to user home directories.	From customer via CMI, default is /home/$homedir_server.
filecoll_config	S	**True** or **false** if file collection management code should be installed.	From customer via CMI, default is false.
supman_uid	S	UID for supman.	
supfilesrv_port	I	File collections port number.	
spacct_enable	S	Flag indicating whether, by default, accounting is enabled on all nodes that have an accounting enabled attribute of **default**.	default is **false**.
spacct_actnode_thresh	I	The SP accounting active node threshold indicates the percentage of nodes for which accounting data must be available, for merging and reporting of the data for a cycle to take place.	default is 80.
spacct_excluse_enable	S	The cluster exclusive use accounting enabled attribute- indicates whether accounting start and end job records will be generated for jobs having exclusive use of the node.	True or false. Default is **false**.
acct_master	I	Specifies which node is to act as the accounting master.	default is 0.
cw_has_usr_clients	S	Either **true** or **false**.	Default is **false**.
code_version	S	Contains the ssp release that is installed on the CWS.	Default is nothing (unknown).
layout_dir	S	Pathname of layout directory for current system partition configuration.	

Attribute Name	*Type*	*Description*	*Comments*
authent_server	S	The type of authentication server used. The possible values are **ssp** (SP authentication services) (**ssp.authent** server, either primary or slave, on the control workstation), **afs** (afs server on either the control workstation or elsewhere), **krb** (SP authentication services or other Kerberos servers on other workstations only).	The default is **krb**. The value is set by **install_cw**.
backup_cw	S	Kernel hostname of backup control workstation.	If value is null, configuration is not HACWS.
ipaddrs_bucw	S	IP addresses of backup control workstation that are not service adapters and are not involved with fail over.	If value is null, the backup control workstation is not reachable as the backup during fail over periods.
active_cw	S	Active control workstation, either control workstation or backup control workstation.	If value is null, configuration is not HACWS.
sec_master	S	Hostname of the DCE master server.	Set with the **setupdce** command.
cds_server	S	Hostname of CDS primary server.	Set with the **setupdce** command.
cell_name	S	Name of DCE cell.	Set with the **create_dcehostname** command.
cw_lppsource_name	S	The name of the LPP source resource from which to obtain NIM file sets for the control workstation.	You must ensure that the AIX level of the LPP source (indicated by the value given to cw_lppsource_name) matches the AIX level installed on your control workstation.
cw_dcehostname	S	Name by which DCE knows the control workstation.	
master_switch_seq	I	Number of the node that is the master switch sequencing node.	
number_switch_planes	I	Number of switch planes.	Specified by the user with the **spswplanes** command.
admin_locale	S	The SP administrative locale for the SP system. The default is the base AIX locale of the CWS.	Set with the **spsitenv** command.

Attribute Name	*Type*	*Description*	*Comments*
SDR_ASCII_only	S	Indicates whether non-ASCII data is allowed to be written to the SDR. If true only data in the base ASCII code range '00'X to '7F'X can be written to the SDR.	Set with the **spsitenv** command.
switch_clock_alt_num	I	Specifies the clocking topology alternate number.	
IsPartitionable	S	Indicates whether this system can be partitioned.	Set by **SDR_config** to `true` unless there is an SP Switch2 or there is no SP frame, in which case it is set to `false`.
kfserver_timeout	I	Contains the value of the KF_TIMEOUT environment variable. This value signifies how long to wait for the transfer of the Kerberos V4 srvtab file.	The default is 30 seconds.

Class = SPDM

Attribute Name	*Type*	*Description*	*Comments*
partition	S	Name of the SP partition using this object.	
central_mgr	S	PTPE Central Coordinator for PTPE monitoring hierarchy in this partition.	
active	I	Indicates if PTPE data collection is active.	
archive	I	Indicates if PTPE data archiving is active.	
organization	I		Obsolete field.
sampling_rate	I	Number of seconds between performance data samples when data collection is active.	
archive_rate	I	Number of seconds between performance data recordings when data archiving is active.	

Class = SPDM_NODES

Attribute Name	*Type*	*Description*	*Comments*
reliable_hostname	S	Same as reliable_hostname in Nodes class.	
node_number	I	Same as node_number is Nodes class.	
node_group	I	Indicates to which PTPE monitoring group this node belongs.	
reports_to	S	reliable_hostname of this node's PTPE Data Manager in the PTPE monitoring hierarchy.	
num_reporters	I	Number of nodes reporting to this node in the PTPE monitoring hierarchy.	

Class = SP_ports

Attribute Name	*Type*	*Description*	*Comments*
daemon	S	Name of a daemon.	
hostname	S	Host on which the daemon runs.	
port	I	Port that the daemon uses on node specified in **hostname**.	

Class = Subnet

Attribute Name	*Type*	*Description*	*Comments*
subnet	S	The subnet ID, in "dot" notation (obtained by adding together an IP address for an adapter and its netmask).	All adapters in the same subnet will have the same subnet ID. This field is not currently filled.
networkName	S	Network to which this subnet belongs.	This field is not currently filled.

Class = Switch

Attribute Name	*Type*	*Description*	*Comments*
switch_number	S	Switch Number	If less than 1000, switches connected to nodes. If greater than 1000, intermediate switches.
frame_number	I	Frame number	
slot_number	I	Slot number within frame.	Node switches equal 17. Intermediate switches equal 2,4,6,8,10,12,14,16.
switch_partition_number	I	Switch partition that the SP Switch is on.	Default is **1**. Used in SP Switch systems only.
switch_type	I	Switch supervisor card type (49, 50, 129, or 132).	
clock_input	I	Clock input source.	SP Switch possible values: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 27, 28, 29, 30, 31, 32, 33, 34
switch_level	I	Microcode level from the switch supervisor.	
switch_name	S	Short model name of the switch.	
clock_source	I	Switch number of the switch providing the clocking signal for the current switch.	
clock_change	S	Clock input has changed since last **Eclock**.	
switch_plane	I	Switch plane number to which this switch is connected.	Values are 0, 1, 2, or 3. Filled in by CSS.
switch_plane_seq	I	A logical switch number for sequencing which can be renumbered.	For example, on a single plane system the first 2 switches are numbered 2 and 4 to allow for expansion up to 4 planes. Filled in by SDR_config processing.

Class = Switch_adapter_port

One of these objects is created for each adapter in SP Switch systems. Two of these objects are created for each adapter in SP Switch2 systems.

Attribute Name	Type	Description	Comments
node_number	I	Relative node number ((frame#-1)*16)+slot.	Same as the node number attribute in the node class. Set during spadaptrs processing.
switch_node_number	I	Switch relative node number.	Set by the fault service daemon.
switch_chip	I	Switch chip number to which this adapter port is connected.	Set by the fault service daemon.
switch_chip_port	I	Switch port to which this adapter port is connected.	Set by the fault service daemon.
adapter_name	I	Name of the switch adapter on which this port exists.	Set during spadaptrs processing.
adapter_port_number	I	Port number within this adapter in sequence beginning with 0.	Set during spadaptrs processing.
switch_number	I	Switch number to which this adapter node is connected.	Set by the fault service daemon.

Class = Switch_partition

This class applies to SP Switch partitions only. It is not used with the SP Switch2.

Attribute Name	Type	Description	Comments
switch_partition_number	I	The partition number for High Performance Switch use.	No longer applicable.
topology_filename	S	The filename of the topology file that is stored in the SDR.	
primary_name	S	The reliable hostname of the switch primary node.	
arp_enabled	S	Address resolution protocol.	Default is **no**.
switch_node_number_used	S	Switch adapter's IP addresses were assigned based on the switch node numbers.	Default is **yes**.
run_phase_duration	I	Length of time in minutes that the switch stays in run phase. Range is 1–117281 minutes.	Default is **2**.
primary_backup_name	S	Reliable host name of this system partition's primary backup node.	

Attribute Name	*Type*	*Description*	*Comments*
oncoming_primary_name	S	Reliable host name of the node that will become the primary node on the next **Estart**.	
oncoming_primary_backup_name	S	Reliable host name of the node that will become the primary backup node on the next **Estart**.	
num_nodes_success	I	Number of nodes in the system partition that successfully received the topology file.	
switch_max_ltu	I	Represents the maximum length of the data portion of an IP packet sent over the switch. This value is determined by internal switch support, and should not be changed.	
switch_link_delay	I	Represents the switch link delay value used by switch support when initializing the switch network. This value is determined by internal switch support, and should not be changed.	
autounfence	I	Tells the fault service daemon on the primary node to enable (1) or disable (0) the automatic unfence feature. Default is 1 to enable autounfence.	The value can be changed using the Estart command. The attribute takes effect at switch initialization or primary node takeover.

Class = Switch_plane

This class applies to SP Switch2 systems only.

Attribute Name	*Type*	*Description*	*Comments*
switch_plane_number	I	The plane number for the SP Switch2.	For SP Switch2 systems only.
topology_filename	S	The filename of the topology file that is stored in the SDR.	For SP Switch2 systems only.

Attribute Name	*Type*	*Description*	*Comments*
primary_name	S	The reliable hostname of the switch primary node.	For SP Switch2 systems only.
primary_backup_name	S	Reliable host name of this system partition's primary backup node.	For SP Switch2 systems only.
oncoming_primary_name	S	Reliable host name of the node that will become the primary node on the next **Estart**.	
oncoming_primary_backup_name	S	Reliable host name of the node that will become the primary backup node on the next **Estart**.	For SP Switch2 systems only.
num_nodes_success	I	Number of nodes in the system partition that successfully received the topology file.	For SP Switch2 systems only.
switch_max_ltu	I	Represents the maximum length of the data portion of an IP packet sent over the switch. This value is determined by internal switch support, and should not be changed.	For SP Switch2 systems only.
switch_link_delay	I	Represents the switch link delay value used by switch support when initializing the switch network. This value is determined by internal switch support, and should not be changed.	For SP Switch2 systems only.
autounfence	I	Tells the fault service daemon on the primary node to enable (1) or disable (0) the automatic unfence feature. Default is 1 to enable autounfence.	The value can be changed using the Estart command. The attribute takes effect at switch initialization or primary node takeover.

Class = switch_responds

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	Relative node number.	
switch_responds	I	0 or 1 if switch is inactive/active on the node.	This is written by switch code in SP Switch systems only.
autojoin	I	Should this node join switch on startup.	This applies in SP Switch systems only.
isolated	I	1 or 0 if this node is isolated from the switch or not.	Applies in SP Switch systems only.
adapter_config_status	S	Status of the switch adapter in the node for SP Switch systems only.	Status can be one of css_ready, diag_fail, microcode_load_fail, or not_configured.
switch_responds0	I	0 or 1 if switch on plane 0 is inactive/active on the node.	This is written by switch code in SP Switch2 systems only.
switch_responds1	I	0 or 1 if switch on plane 1 is inactive/active on the node.	This is written by switch code in SP Switch2 systems only.
switch_responds2	I	0 or 1 if switch on plane 2 is inactive/active on the node.	This is written by switch code in SP Switch2 systems only.
switch_responds3	I	0 or 1 if switch on plane 3 is inactive/active on the node.	This is written by switch code in SP Switch2 systems only.
autojoin0	I	Should this node join switch on startup.	For switch plane 0 in SP Switch2 systems only.
autojoin1	I	Should this node join switch on startup.	For switch plane 1 in SP Switch2 systems only.
autojoin2	I	Should this node join switch on startup.	For switch plane 2 in SP Switch2 systems only.
autojoin3	I	Should this node join switch on startup.	For switch plane 3 in SP Switch2 systems only.
isolated0	I	1 or 0 if this node is isolated from the switch or not.	For switch plane 0 in SP Switch2 systems only.
isolated1	I	1 or 0 if this node is isolated from the switch or not.	For switch plane 1 in SP Switch2 systems only.
isolated2	I	1 or 0 if this node is isolated from the switch or not.	For switch plane 2 in SP Switch2 systems only.
isolated3	I	1 or 0 if this node is isolated from the switch or not.	For switch plane 3 in SP Switch2 systems only.

Class = SysNodeGroup

Attribute Name	*Type*	*Description*	*Comments*
name	S	Name associated with a node group.	The first character of a node group name must be a letter. The remaining characters may be letters, numbers, . (period), or _ (underbar).
defList	S	Nodes and node groups which are members of this node group.	For a node group named “A”, a list of nodes and node groups that belong to “A” directly (not through member node groups).

Class = Syspar

Attribute Name	*Type*	*Description*	*Comments*
syspar_name	S	Hostname of system partition.	
ip_address	S	IP address of system partition.	
install_image	S	The image installed on this system partition.	
syspar_dir	S	The directory from which this system partition was created.	
code_version	S	PSSP components code version in this partition.	
haem_cdb_version	S	Event Management Configuration Database (EMCDB) version string.	
auth_install	S	Set of authentication methods to be installed on nodes in this partition.	
auth_root_rcmd	S	Set of root authorization files defined for this partition.	
ts_auth_methods	S	Set of active SP trusted services authentication methods for this partition.	
auth_methods	S	Set of active AIX remote command authentication methods for this partition.	

Class = Syspar_map

Attribute Name	*Type*	*Description*	*Comments*
syspar_name	S	Short hostname of a system partition.	
syspar_addr	S	IP address of a system partition.	
node_number	I	A node number in this system partition.	The node number assigned to the node.
switch_node_number	I	The switch node number of this node.	For SP-attached server nodes, this value is the switch node number for the switch port to which the SP-attached server node is connected. In a switchless system, this value is set by the customer.
used	I	Is this node on IC bus of frame controller?	For a SP-attached server, this value is set to 1.
node_type	S	The type of node: standard, dependent.	For a SP-attached server node, this value is set to standard.

Class = Syspar_ports

Attribute Name	*Type*	*Description*	*Comments*
subsystem	S	Name of a system partition-sensitive subsystem.	
port	I	Port number used for intrasubsystem communication.	

Class = TaskGuide

Attribute Name	*Type*	*Description*	*Comments*
tgsbase	S	Base name of the TaskGuide script that was used.	Set by TaskGuide when creating an object of this class. For example, *confnode* would correspond to confnode.sgs, the *Configure New Nodes* TaskGuide.

Attribute Name	*Type*	*Description*	*Comments*
datetime	S	A data/time stamp recording when the TaskGuide was started (format varies with locale).	Set by TaskGuide when creating an object of this class.
userid	S	The userid that ran the TaskGuide.	Set by TaskGuide when creating an object of this class.
status	S	An indication of whether the TaskGuide was completed or not.	Initialized to *incomplete* when TaskGuide creates an object of this class. Changed to *complete* when the TaskGuide is completed.
notes	S	Terse notes that further identify the TaskGuide run to which this object pertains.	Generally left uninitialized when TaskGuide creates an object of this class. Set (and possibly reset) by TaskGuide just as soon as it has some identifying notes formulated. For example, the *Add Frames* TaskGuide might set *Frames 2,3*.
tgvals	S	The name of the SDR system file where the TaskGuide checkpoint or resume values have been saved.	Initialized by TaskGuide when creating an object of this class. The format of the SDR system file name is *tgsbase.datetime.tglvals*. Will be changed to a null string at the same time TaskGuide changes the status attribute to *complete*.
tglog	S	The name of the SDR system file where the TaskGuide log of the run has been saved.	Set by TaskGuide when creating an object of this class. The format of the SDR system file name is *tgsbase.datetime.tglog*.

Class = TS_Config

For the default settings of the attributes in this class, see the man pages for the **hatsctrl** command in *PSSP Command and Technical Reference*.

Attribute Name	*Type*	*Description*	*Comments*
Frequency	I	The frequency, in heartbeats per second, with which heartbeats are sent out.	
Sensitivity	I	The number of heartbeats from the neighboring node that can be missed before the neighbor is declared inoperative.	

Attribute Name	*Type*	*Description*	*Comments*
Run_FixPri	I	Whether the execution priority is fixed or floating (1=fixed, 0=floating).	
FixPri_Value	I	The value of the execution priority that is used on the **set_priority** system call.	
Log_Length	I	The maximum number of lines in a log file. The file is wrapped after it reaches this limit.	
Pinning	S	Determines whether the Topology Services daemon should run with its text or data pinned in memory. Text = pin text area Data = pin data area Proc = pin text and data areas NULL = does not ping any area	This field is not currently filled. The daemon has its text area pinned by default.

Class = TS_Tunable

Attribute Name	*Type*	*Description*	*Comments*
networkType	S	The type of network. For example, FDDI, token ring, ethernet, and so on.	
hbInterval	I	Heartbeat send frequency, in seconds, for this type of network.	
hbTolerance	I	Number of heartbeats from the neighboring node that can be missed before the neighbor is declared inoperative.	

Class = Volume_Group

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	The node number for Volume_Group. It is an integer representing a node number.	

Attribute Name	*Type*	*Description*	*Comments*
vg_name	S	The customer supplied volume group name.	This is a customer supplied name for easy reference. It is initially set to "rootvg".
pv_list	S	A list of physical volumes. Valid formats are: hdisk, hdisk, ...hdisk, connwhere, connwhere, ...conwhere location:location:...location:	Initially set to "hdisk0".
rvg	S	Specifies whether the volume group is a root volume group. Valid values are true or false.	Initially set to "true".
quorum	S	Specifies whether the quorum is set to on for this volume group. Valid values are true or false.	Initially set to "true".
copies	I	Specifies the number of copies for the volume group. Valid values are 1 or 2 or 3.	Initially set to 1.
mapping	S	Specifies whether mapping is set to on. Valid values are true or false.	Initially set to "false".
install_image	S	The name of the mksysb install image to install next.	Initially set to "default".
code_version	S	PSSP code version to use for next install.	Derived from Syspar.
lppsource_name	S	Name of the lppsource resource to use for next install.	Initially set to "default".
boot_server	S	The node_number of the boot/install server.	Default depending upon the node location.
last_install_time	S	A date string specifying when the node was last installed.	Initial
last_install_image	S	A string specifying the name of the last image installed on the node.	Initial
last_bootdisk	S	A string specifying the logical device name of the last volume from which the node booted.	Initial

|
Class = VSD_Cluster_Info

Attribute Name	*Type*	*Description*	*Comments*
node_number	I	SP node number.	
cluster_name	S	Name of this cluster.	
CVSD_node_number	I	CVSD cluster node number.	
cvgs_defined	I	Number of concurrent volume groups that have been defined on this node.	

Class = VSD_Fence

Attribute Name	*Type*	*Description*	*Comments*
minor_number	I	The unique minor number of a vsd that is fenced out of more than one node.	
commit	I		**0** if in process of being committed; **1** if committed.
Map	S	A hex dump of the map designating the nodes that have IBM VSD fenced out.	

Class = VSD_Global_Volume_Group

Attribute Name	*Type*	*Description*	*Comments*
global_group_name	S	Global Volume Group name.	
local_group_name	S	Local Volume Group name.	
primary_node	I	Primary node for this volume group.	This is a relative node number.
secondary_node	I	Secondary node for this volume group.	This is a relative node number and is optional.
eio_recovery	I	Denotes if recovery should be made from a hardware error.	
recovery	I	Denotes if recovery was made from a hardware error.	**0** = recovery was not made; **1** = recovery was made.
primary_ts	S	Primary node for a tail.	

Attribute Name	*Type*	*Description*	*Comments*
secondary_ts	S	Secondary node for a tail.	
server_list	S	List of concurrent servers for this volume group.	
vsd_type	S	Specifies the type of virtual shared disk volume group.	VSD specifies serial access and CVSD specifies concurrent access.

Class = VSD_Minor_Number

Attribute Name	*Type*	*Description*	*Comments*
minor_number	I	Unique minor numbers.	

Class = VSD_Table

Attribute Name	*Type*	*Description*	*Comments*
VSD_name	S	Volume group name.	
global_group_name	S	Global Volume Group name.	Same names as global_group_name in VSD_Global_Volume_group.
logical_volume_name	S	The name of the logical volume comprising this vsd.	
minor_number	I	Minor number from minor table.	
option	S	Options associated with this vsd.	**cache** or **nocache** are the permissible values.
size_in_MB	I	The size of the logical volume pointed to by a vsd.	
lv_blk0_pdev	I	The physical device pointed to by the logical volume.	
lv_blk0_pbn	I	The offset a logical volume resides on on the physical device.	

Appendix F. Changing IP Address and Host Name on SP Systems

This appendix describes how to change the primary SP Ethernet IP address and host name for SP nodes and SP-attached servers, or the primary IP address and host name for the control workstation and SP-controlled Netfinity servers. IBM suggests you avoid making any host name or IP address changes if at all possible. The tasks are tedious and in some cases require rerunning the SP installation steps. For more information on SP networks, see the book *IBM RS/6000 SP: Planning Volume 2, Control Workstation and Software Environment*.

Changing the IP address or host name of SP nodes affects the entire SP system. IP address and host names are located in the SDR objects as attributes. IP address and host names are also kept in other system-related files that are located on SP nodes and the control workstation. It is imperative that all new IP addresses and host names you use are resolvable on your SP system.

The following PSSP components and related products require careful consideration and attention when you change any IP address or host name:

- SP security, especially with the Distributed Computing Environment (DCE)
- Network Installation Manager (NIM)
- System partitioning
- IBM virtual shared disks
- General Parallel File System (GPFS)
- High Availability Control Workstation (HACWS)
- High Availability Cluster Multi-Processing (HACMP)
- RS/6000 Cluster Technology (RSCT) services
- Problem management subsystem
- Performance monitor services
- Extension nodes
- SP-controlled Netfinity servers

SDR Objects with IP Addresses and Host Names

The following SDR objects reference the host name and IP address in the SP system for PSSP subsystems:

Adapter	Contains the IP addresses used with the switch **css0** adapter, or the Ethernet, FDDI, or token ring adapters.
Frame	Contains the Monitor and Control Node **MACN**, and HACWS **backup_MACN** attributes on the control workstation that work with host names
JM_domain_info	Contains the host names for Resource Manager domains
JM_Server_Nodes	Contains the host names for Resource Manager server nodes

Node	Contains the initial or reliable host names, the DCE host name, and the IP address for SP nodes and boot servers. The nodes are organized by system partitions.
Pool	Contains host names for Resource Manager pools.
SP	Contains control workstation IP address and host names. Contains the host name used with Network Time Protocol (NTP), user management, and accounting services.
SP_ports	Contains the host name used with **hardmon** and the control workstation.
Switch_partition	Contains host name for primary and backup nodes used to support the SP Switch.
Switch_plane	Contains host name for primary and backup nodes used to support the SP Switch2.
Syspar	Contains the IP address and SP_NAME with system partitions.
Syspar_map	Provides the host name and IP address on the control workstation for system partitions.
pmandConfig	Captures the SP node host name data working problem management.
SPDM	Contains host name for Performance Monitor status data.
SPDM_NODES	Contains host name for SP nodes and organized by system partition.
DependentNode	Contains host name for dependent extension node.
DependentAdapter	Contains IP address for dependent extension node adapter.
ProcessorExtensionNode	Contains host name for SP-controlled Netfinity server.

SP System Files with IP Addresses and Host Names

The following files contain the IP address or host name that exist on SP nodes and the control workstation. IBM suggests that you look through these files when completing the procedures for changing host names and IP addresses for your SP system. The following files are available for PSSP systems:

.rhosts	This file, in the home directory of the root user, contains host names used exclusively with AIX-authenticated **rcmd** services.
.klogin	This file, in the home directory of the root user, contains host names used exclusively with Kerberos V4-authenticated **rcmd** services.
.k5login	This file, in the home directory of the root user, contains host names used exclusively with Kerberos V5-authenticated **rcmd** services.
/etc/hosts	Contains IP addresses and host names used with the SP system.
/etc/resolv.conf	Contains the IP address for Domain Name Service (DNS) (Optional).
/var/yp/*nis*	References the host name and IP address with Network Information Service (NIS).

/etc/krb5.conf
Works with host name for DCE.

/etc/krb.conf
Works with the host name for the authentication server.

/etc/krb.realms
Works with the host name of the SP nodes and authentication realm.

/etc/krb-srvtab
Provides the authentication server key using host name.

/etc/SDR_dest_info
Specifies the IP address of the control workstation and the SDR

/etc/ssp/cw_name
Specifies IP address of control workstation host name on SP nodes that work with node installation and customization.

/etc/ssp/server_name
Specifies IP address and host name of the SP boot/install servers on SP nodes working with node customization.

/etc/ssp/server_hostname
Specifies IP address and host name of the SP install servers on SP nodes working with node installation.

/etc/ssp/reliable_hostname
Specifies IP address and host name of the SP node working with node installation and customization.

/etc/ntp.conf
Works with the IP address of the NTP server (Optional).

/etc/filesystems
Can contain the IP address or host name of NFS systems (mainly used on **/usr** client systems).

/tftpboot/*host***.config_info**
Contains the IP address and host name for each SP node. It is found on the control workstation and boot servers.

/tftpboot/*host***.intstall_info**
Contains the IP address and host name for each SP node. It is found on the control workstation and boot servers.

| **/spdata/sys1/k4srvtabs/***host***-new-srvtab**
| Provides authentication server keys using host name. It is found on the
| SP control workstation.

/etc/rc.net
Contains the alias IP addresses used with system partitions

/etc/niminfo
Works with the NIM configuration for NIM master information

/etc/sysctl.acl
Uses host name that works with Sysctl ACL support

/etc/logmgt.acl
Uses host name that works with Error Log Mgt ACL support

/spdata/sys1/spmon/hmacls
Uses short host name that works with hardmon authentication services

/etc/jmd_config.*SP_NAME*
Works with host names for Resource Management on the control workstation for all defined SP_NAME syspars.

/usr/lpp/csd/vsdfiles/VSD_ipaddr
Contains the SP node IBM Virtual Shared Disk adapter IP address

/spdata/sys1/ha/cfg/em.*SP_NAME***cdb.***data*
Uses Syspar host name that works with configuration files for Event Management services.

/etc/ha/cfg
Uses Syspar host name that works with configuration files for Event Management services.

/var/ha/run/*rsct_services*
Uses Syspar host name that contains the run files for the RSCT services, which include **haem** (Event Manager), **hats** (Topology Services) **hags** (Group Services - Ethernet), and **hagsglam** (Group Services - switch).

/var/ha/log/*rsct_services*
Uses Syspar host name that contains the log files for the RSCT services.

/var/adm/SPlogs/pman/*data*
Uses Syspar host name that contains the log files for the Problem Management subsystem.

/etc/services
Specifies short host name based on *SP_NAME* partition that work with RSCT services port numbers

/etc/auto/maps/auto.u
Contains host names of the file servers providing NFS mounts to Automount

/etc/amd/amd-maps/amd.u
Contains host names of the file servers providing NFS mounts to Amd

/var/sysman/sup/*file_collection***/host**
Contains host names of the control workstation and of the SP nodes, servers, and other workstations that are clients of this *file_collection*.

Changing an IP Address or Host Name

Changing an IP address or host name on your SP system causes changes to the control workstation and SP nodes. Be certain that you understand, have planned, and have documented all the IP address and host name changes you are about to make. It is particularly important that you understand which SP nodes are boot servers in your SP configuration. This procedure does not dictate precise instructions for performing every task. It lists the tasks you need or might need to perform and gives some examples of how you might do it. However, it is up to you to evaluate, based on your knowledge of your SP system, which tasks must be performed, when, and precisely how to perform them.

This procedure at the highest level includes the following:

1. Create a **mksysb** backup file of the control workstation, a backup file of each node, and also back up critical file systems that might be on the control workstation and on the nodes. You can use the Create Node Image TaskGuide where applicable.
2. If any part of the SP system is a member of a DCE cell, do the following:
   a. See the information on handling network reconfigurations in the book *IBM DCE 3.1 for AIX: Administration Guide–Core Components*.
   b. See the information on changing the IP address of a DCE server and on hostname change in the book *IBM DCE 3.1 for AIX: Problem Determination Guide*.
   c. You must have DCE cell administrator authority to run the **config_spsec**, **setupdce**, and **rm_spsec** commands. They are shown in this procedure as being run from the SP control workstation. Using different option flags, you can run them remotely from any appropriately configured workstation. If you do not intend to run them from the SP control workstation, see the book *PSSP: Command and Technical Reference* for the options available and note your changes in the steps of this procedure where they occur.
3. Develop your own customized procedure by evaluating, based on your knowledge of your system, which tasks to perform for DCE or other software on your system and how to perform them.
4. Evaluate the rest of this procedure considering where your additional tasks fit in and make notes to perform them plus only those tasks listed here that apply to your system configuration. The rest of this procedure is detailed in the sections that follow and include:
   a. Performing tasks on each node.
   b. Performing tasks on the control workstation.
   c. Performing tasks in HACWS configurations.
   d. Verifying that each node acknowledges the changes.
5. Follow your customized procedure, which includes all the tasks that apply to your system, carefully performing the steps in proper sequence and on the nodes and control workstation respectively as instructed.

Performing Tasks on Each Node

Perform the following tasks on all PSSP nodes before making updates to the control workstation.

On each PSSP node, perform each of the following tasks ***if they apply to your SP system***. You can perform many of the tasks by using the SP Perspectives GUI. You might prefer to automate some tasks by implementing user shell scripts and by using the SP distributed shell (**dsh**) services from the control workstation to the target nodes. The important thing is that you do ***perform each task on each node:***

1. Stop all applications that are dependent on IBM VSD or RVSD subsystems.

   Two such applications are GPFS and ORACLE. For example, to stop GPFS use the command:

   ```
   /usr/lpp/ssp/bin/stopsrc -s mmfs
   ```

2. Unconfigure virtual shared disks.

   Determine if there is a virtual shared disk on the node, regardless of whether it is recoverable, concurrent, or hashed. You can visually tell which nodes have any by using the Virtual Shared Disk Perspective graphical user interface. If there are any vsd nodes, you can stop the RVSD subsystem, and unconfigure all the virtual shared disks on all the nodes. Another way is to use the command line interface on one node at a time. You can issue the **/usr/lpp/csd/bin/vsdatalst -n** command. If you receive a message indicating "not found" or this SP node is not listed in the results, go to the next task. If this SP node is listed, stop the RVSD subsystem if it is running, then suspend, stop, and unconfigure the virtual shared disks for this SP node using the commands:

   ```
   /usr/lpp/csd/bin/ha.vsd stop      /* run if RVSD subsystem is active */
   /usr/lpp/csd/bin/suspendvsd -a
   /usr/lpp/csd/bin/stopvsd -a
   /usr/lpp/csd/bin/ucfgvsd -a
   ```

3. Stop any other application you might have running that depends on RSCT services.

   Shutdown the applications that work with RSCT services. The RSCT services include Topology Services, Group Services, Event Management, Problem Management, and Performance Monitor.

4. Stop and remove the RSCT services

   Execute the **syspar_ctrl** command to stop and remove these resources.

   ```
   /usr/lpp/ssp/bin/syspar_ctrl -c
   ```

5. Update the NIM files and configuration

   If available, update the **/etc/niminfo** file to provide the new host name and IP address changes for the NIM client, NIM master, and NIM file references. If the SP node is currently a NIM master (boot/install server), remove the NIM ODM objects and NIM master configuration files from the SP node by issuing the **delnimmast** command:

   ```
   /usr/lpp/ssp/bin/delnimmast -l node_number
   ```

6. Disable HACMP on nodes

   Use instructions from the HACMP publications to disable the HACMP configuration. The nodes will not be able to communicate during this activity. After nodes are backed up and running again, reconfigure or re-enable the HACMP configuration.

7. Update DCE client information

   Use the SMIT DCE client panels and dialog boxes to make proper changes to refer to DCE clients and DCE servers, IP addresses, and host names. Do one of the following:

   - For PSSP 3.2 nodes that support SP DCE exploitation, you need to remove SP DCE server key files and DCE ACLs. You also need to unconfigure the local DCE client configuration information on the SP node. Use the commands:

     ```
     /usr/lpp/ssp/bin/rm_spsec -t local
     /bin/unconfig.dce -config_type local all
     ```

- For older PSSP level nodes or PSSP 3.2 nodes that do not support SP DCE exploitation, you need to manually update the DCE client configuration on the SP node and the DCE server.

8. Update PSSP files for updates on each PSSP node

   Update the following files to reflect the new host name and IP address for the SP node and servers:

   a. Update the **/etc/SDR_dest_info** file using the new control workstation and SDR IP addresses and host names.
   b. Update the **/etc/ssp/ cw_name**, **server_hostname** and **server_name** files to reference the new boot server host name and IP address.
   c. Update the **/etc/ssp/reliable_hostname** file to reference the new SP node client host name and IP address.
   d. Make sure that the SP_NAME environment variable is updated or set to blank (export SP_NAME=).
   e. For Kerberos V4, issue **/usr/lpp/ssp/kerberos/bin/kdestroy** to remove any active Kerberos ticket-granting-tickets. You might need to update the **/etc/krb.conf** file if the authentication server is changed. IBM suggests renaming the **/etc/krb-srvtab** file on the SP node.
   f. Update the files controlling authorization for root remote command access. Depending on your security configuration, you might have one or more of the following files: **/.k5login**, **/.klogin**, **/.rhosts**.

9. Update the **en0** interface

   To make sure that all IP addresses and host names are resolvable and that the SP node can properly communicate with the control workstation during reboot activity, do the following on each node:

   a. If the host name of the node is the **en0** interface and that host name or IP address has changed, do the following:

      1) To change the host name and the IP address, you can use SMIT **mktcpip** or run the **mktcpip** command on each SP node. For example, to change the host name of node k22n06 to the new IP address 129.40.88.70 and new host name k88n06, use the command:

         ```
         /usr/sbin/mktcpip -i en0 -h'k88n06.ppd.pok.ibm.com' -a'129.40.88.70'
         ```

      2) After running the **mktcpip** process, the node loses the current network connection to the control workstation and the other SP nodes. Any further updates to the SP node need to be performed using the **s1term** command on the **tty0 console**. You might be able to kill the telnet or rlogin process from the control workstation or the home machine to regain the telnet window.

   b. If the host name of the node is not the **en0** interface, to change the **en0** IP address without affecting the host name of the node, you can use the **chdev** command.

      For example, to change the IP address of en0 to 129.40.88.70, use the command:

      ```
      chdev -I en0 -a netaddr=129.40.88.70
      ```

   c. Update any other attributes for the interface that have changed, such as subnet_mask.

That completes the updates required on nodes. ***Do not reboot the nodes until you are instructed to.*** Continue with "Performing Tasks Required on the Control Workstation" on page 586 to make the changes that are necessary on the control workstation.

Performing Tasks Required on the Control Workstation

The following tasks need to be performed by the **admin** (root) user on the control workstation when changing the SP Ethernet IP address or host name:

1. Be certain you have a backup of the current **/spdata** file system and a **mksysb** backup before making any IP address and host name changes to the control workstation.
2. To save the current SDR attributes, run the command **/usr/lpp/ssp/bin/SDRArchive**. This command saves SDR information for all system partitions.
3. If you are currently in an HACWS configuration, properly disable the backup control workstation and unconfigure HACWS before changing any IP address and host names for the control workstation. See "Performing Tasks in HACWS Configurations" on page 592 for more information.
4. If you use an SP switch, quiesce the switch in each SP system partition at this time.
5. Stop and remove all active resources that work with the RSCT services. You can run the command:

   ```
   /usr/lpp/ssp/bin syspar_ctrl -G -c
   ```

   Usage Note

   Tasks 6 through 17 are required when there are IP address and host name changes made to the control workstation. If there are only changes being made to the SP nodes, go to step 18 on page 589.

6. If you use DCE authentication for SP trusted services, remove SP DCE server key files, principals, and DCE ACLs from the DCE database for the control workstation. Unconfigure the local DCE client configuration information on the control workstation. If you are changing IP address or host name of the DCE server, reconfigure the SP security authentication configuration of DCE from the beginning. Run the commands:

   ```
   rm_spsec -t local
   rm_spsec -t admin cws_dce_hostname
   /bin/unconfig.dce -config_type local all
   ```

   Complete the DCE admin unconfiguration from a system with access to the DCE cell. Unconfigure all adapters for the changed control workstation. You need cell administrator authority for this task. Run the command:

   ```
   /bin/unconfig.dce -config_type admin -dce_hostname cws_dce_hostname \
   -host_id adapter_host_name all
   ```

7. Stop PSSP daemons and remove current source master objects (**sdrd**, and **hardmon** services) on the control workstation. Use the **stopsrc** command to stop PSSP resources. Remove the SDR source master object for each defined system partition (*SP_NAME*).

```
/bin/stopsrc -g sdr
/bin/stopsrc -s hardmon
/bin/stopsrc -s supfilesrv
/usr/lpp/ssp/bin/sdr -spname SP_NAME rmsrc
```

8. Using **mktcpip** or the **chdev** command, specify IP address or host name changes required for the control workstation. This includes changes being made for any affected adapter interfaces. It is also important to make appropriate updates to the route tables, netmasks, and gateway servers.

9. If multiple system partitions exist, update the **/etc/rc.net** file to reference the new alias address used for each system partition. Issue **/etc/rc.net** or execute **ifconfig** command to configure the new alias IP addresses. You can issue the **netstat -ni** command to validate the new alias addresses. The old alias addresses used with system partitions will be removed during the next reboot of the control workstation.

10. Manually update the **/etc/SDR_dest_info** and **/spdata/sys1/spmon/hmacls** files to the new IP address and host name for the SDR and hardmon interfaces.

    Manually update the SDR system partition map file **/spdata/sys1/sdr/system/classes/Syspar_map** to reflect the new IP address and their SP_NAME values with each system partition.

    Move the system partition directories found at location **/spdata/sys1/sdr/partitions** from the old IP address to the new IP address for each system partition being modified.

    ```
    /bin/mv old_IP_addr new_IP_addr
    ```

    Manually update the SDR system partition file **/spdata/sys1/sdr/partitions/***new_IP_addr***/classes/Syspar** to reflect the new IP address and their SP_NAME host name values for each defined system partition.

| 11. You need to update the SP security configuration if you use DCE or Kerberos
| V4 authentication for SP trusted services. Do the following:

| a. For Kerberos V4

| Perform this step only for host name and domain changes for the control
| workstation. It is not required for changes made to control workstation IP
| addresses or to updates for SP nodes.

| Issue the **setup_authent** script to create authentication services for the
| new host names being used. See the step "Initialize RS/6000 SP
| Authentication Services" in *PSSP: Installation and Migration Guide*. The
| **setup_authent** script will get an SDR error attempting to set the nodes to
| customize. You will set the nodes to customize in a later step.

Manually check that the authentication files **/etc/krb.conf /etc/krb.realms** reference the proper host names and domain. You can issue **/usr/lpp/ssp/kerberos/bin/ksrvutil list** to make sure that the **rcmd** and **hardmon** services reference the new host names in the **/etc/krb-srvtab** file. You might also need to recreate Kerberos principals for any users that were previously defined in the Kerberos database. You can use the **lskp**, **mkkp**, and **add_principal** commands to list, make, and add Kerberos principals.

| b. For DCE

Configure the DCE client information using the updated IP addresses and host names. Make sure you have proper network communication to the DCE server. Both an admin and a local DCE configuration are required. You need root user and DCE **cell_admin** authority to add the SP security services for the control workstation into the DCE database. You can do the following:

1) On a system with access to the DCE cell, to admin configure all the adapters on your control workstation run the following command:

```
/bin/config.dce -config_type admin -lan_profile lan_profile_id \
-dce_hostname new_dce_hostname -host_id adapter_host_name sec_cl cds_cl
```

2) To complete the configuration of the DCE clients on the control workstation, run the command:

```
/bin/config.dce -config_type local -cell_name DCE_cell_name \
-dce_hostname new_dce_hostname -sec_master sec_master_hostname \
-cds_server cds_server_hostname -autostart yes sec_cl cds_cl rpc
```

3) Run the commands:

```
/usr/lpp/ssp/bin/config_spsec -v -c
/usr/lpp/ssp/bin/create_keyfiles -v -c
```

12. Create the new source master resources for each SDR object, and then start the SDR and hardmon daemons.

```
sdr -spname SP_NAME mksrc new_IP_addr (for each Syspar)
startsrc -g sdr
startsrc -s hardmon
```

13. DCE principals and key files have already been created for the default partition. You must now create principals and key files for any other partitions that are using DCE. You need DCE cell administrator authority to run the **config_spsec** command. Being logged in as root with default credentials is sufficient to run the **create_keyfiles** command. Run the following commands:

```
config_spsec -v -p partition_name
create_keyfiles -v -p partition_name
```

14. After the SDR daemon is properly activated on the SP system, manually issue **SDRChangeAttrValues** for the control workstation.

    - To change the **hostname** attribute using the new host name for **SP_ports**, enter:

      ```
      SDRChangeAttrValues SP_ports hostname=new_CWS_hostname
      ```

    - To change the **MACN** attribute using the new host name for **Frame**, enter:

      ```
      SDRChangeAttrValues Frame MACN=new_CWS_hostname
      ```

    - To change the **control_workstation** attribute using the short host name for **SP**, enter:

      ```
      SDRChangeAttrValues SP control_workstation=new_CWS_short_hostname
      ```

    - If you have changed your control workstation hostname, you might want to change the cw_dcehostname attribute to match. Run the **SDRChangeAttrValues** command to set the cw_dcehostname to null, then run the **create_dcehostname** command. For example:

```
SDRChangeAttrValues SP cw_dcehostname=""
create_dcehostname
```

15. Remove the current Network Installation Manager (NIM) ODM database and configuration files on the control workstation.

    Issue the command:

    ```
    /usr/lpp/ssp/bin/delnimmast -l 0
    ```

    Correct entries in the **/etc/niminfo** file that reference the old IP address and host names.

    Correct entries in the **/etc/exports** file that reference the old IP address and host names. Then stop and start the NFS subsystem.

16. Using the Set Site Environment Information TaskGuide or the **spsitenv** command, specify any host name changes that might be referenced for NTP, printing, and user management. See the step "Enter Site Environment Information" in *PSSP: Installation and Migration Guide* (Optional).

17. Reboot the control workstation now. This establishes a clean system to reflect the IP address and host name changes. You should verify that all PSSP daemons are activated from **/etc/inittab** and the system resource master.

    Usage Note

    The remaining steps for the control workstation involve updating the SDR and SP system files for the SP node objects. Remember, some of the steps might be optional depending on your SP configuration changes.

18. If you have extension nodes, like an SP Switch Router, you might need to reconfigure its host name and IP address. You can use CMI or the **endefnode** and **endefadapter** commands. See Chapter 18, "Managing Extension Nodes" on page 279 for instructions.

19. If your SP supports an SP-controlled Netfinity server, you might need to update its host name. You can use CMI or the **sppenode** command.

20. If you use DCE authentication for SP trusted services, remove SP DCE server key files, principals, and DCE ACLs from the DCE database for each node. Unconfigure the local DCE client configuration information for each node. Delete all adapters on each node. Reissue the **unconfig.dce** command for each node and each adapter on each node. DCE cell administrator authority is required for this task. Use the commands:

    ```
    /usr/lpp/ssp/bin/rm_spsec -t admin old_dcehostname
    /bin/unconfig.dce -config_type admin -dce_hostname old_dcehostname\
    -host_id adapter_host_name all
    ```

21. Update configuration files on the control workstation

    Various AIX and SP files might need to be updated to reflect IP address or host name changes. Look through the following files for required updates.

    a. Update any files that are involved with host name resolution. The files are **/etc/hosts**, **/etc/resolv.conf** (DNS) and **/var/yp/*** (NIS).

    b. Update the **/etc/filesystems** and **/etc/jmd_config.***SP_NAME* files for your SP configuration.

c. Make sure your **/tftpboot/script.cust** file and **/tftpboot/firstboot.cust** file are updated to reflect IP address and host name changes. Instead of hard coding host names, you can reference the $SERVER and $CWS variables.

d. Update any DCE client and server files if supporting a DCE configuration.

22. Update the SDR node objects by using commands or the SMIT-based SP Configuration Management Interface (CMI). You can perform the following tasks for each system partition by exporting the SP_NAME variable (for example, export SP_NAME=*SP_NAME*).

    a. Using CMI or the **spethernt** command, specify the new SP Ethernet IP address or host name changes required for the SP nodes. See the step “Enter Required Node Information” in *PSSP: Installation and Migration Guide*.

    b. Using CMI or the **spadaptrs** command, reset the switch **css0** adapter, and other adapters that need to reference the new IP address or host names being changed. See the step “Configure Additional Adapters for Nodes” in *PSSP: Installation and Migration Guide*.

    c. Using CMI or the **sphostnam** command, reset the initial host name that you want to use in your system. See the step “Configure Initial Host Names for Nodes” in *PSSP: Installation and Migration Guide* (Optional).

    d. Using CMI or the **spchvgobj** and **spbootins** commands, reset all boot/install servers to reference the new SP Ethernet IP address and host names. It is important that you set your SP node boot/install servers into the proper configuration for your SP system. If you have system partitions, you should have already designated the proper PSSP boot server nodes.

    ```
    spchvgobj -r rootvg -n boot_node -l node_list
    ```

    You need to set the bootp response to **customize** for all the SP nodes.

    ```
    spbootins -r customize -l node_list
    ```

    You can issue the **splstdata -G -b** command to verify the correct boot information for the SP nodes.

    The **spbootins** command runs the **setup_server** command which creates all the NIM-based files and resources required for installation. It also creates the authentication **rcmd** principals for the new SP node host names.

    You might want to validate that the following files have the proper IP addresses and host names defined.

    - **/etc/ntp.conf**
    - **/tftpboot/***host***.config_info**
    - **/tftpboot/***host***.install_info**
    - **/tftpboot/***host***-new-srvtab**

    e. If you are using DCE authentication and if you have changed the reliable_hostnames of the node, you might want to change the dce_hostnames of the node to match. For each node you want to change, run the **SDRChangeAttrValues** command to set the dce_hostanme to null, then run the **create_dcehostname** command to recreate the dce_hostnames based on the new reliable_hostnames. For example, run the commands:

```
SDRChangeAttrValues Node node_number==xx dcehostname=""
SDRChangeAttrValues Node node_number==yy dcehostname=""
/usr/lpp/ssp/bin/create_dcehostname
```

23. Update the SP security configuration for the SP nodes.

    a. You need DCE cell administrator authority to run the **setupdce** and **config_spsec** commands and you must be root to run the **create_keyfiles** command. When using DCE authentication for SP trusted services, run the following commands:

    ```
    /usr/lpp/ssp/bin/setupdce -v
    /usr/lpp/ssp/bin/config_spsec -v
    /usr/lpp/ssp/bin/create_keyfiles -v
    ```

    b. For all SP security configurations, create the root files for remote command processing on the control workstation. The possible files are **/.k5login** for Kerberos V5, **/.klogin** for Kerberos V4, and **/.rhosts** for standard AIX. You can run the command:

    ```
    /usr/lpp/ssp/bin/updauthfiles
    ```

    The **updauthfiles** command adds the new hostnames to **/.k5login**, **/.klogin**, or **/.rhosts** but it does not delete obsolete hostnames. Manually edit these files to remove entries for obsolete hostnames or to change any user added entries.

    c. Make certain the security options are properly set. Do the following:

       1) To check if the current security settings for each of the SP system partitions are properly set, you can use the **splstdata -p** command.

       2) Do not attempt to change your security setting during this procedure unless you must fix them because of this procedure. If any changes are necessary, see "Managing the Security Configuration" on page 55.

24. If your SP system supports system partitions, reissue the system partitioning steps found in Chapter 16, "Managing System Partitions" on page 247. The system partitioning **spapply_config** command re-creates the proper PSSP daemons and resynchronizes the SDR objects to reflect any IP address and host name changes.

    If you do not execute the system partitioning step, you will then need to create the source master objects and start the daemons for the RSCT services using the **syspar_ctrl -G -A** command.

    ```
    /usr/lpp/ssp/bin/syspar_ctrl -G -A
    ```

25. For each PSSP boot server node, you should have already unconfigured NIM during PSSP node update activities. During the node customization, **setup_server** creates the proper install files for the nodes they are to customize. Since the SP nodes are in **customize** mode, most configuration files are updated to reflect the IP address and host name changes.

    Attention: Some files will not be updated on the nodes during the customization. You can **rcp** these files from the control workstation to the SP nodes by including them in the **/tftpboot/script.cust** file or the **/tftpboot/firstboot.cust**. These can include the **/etc/resolv.conf**, **.rhosts**, and other SP customer-owned files.

26. If you have a switch on your SP system, reinitialize the switch interfaces.

- For an SP Switch, in each SP system partition reset the primary_name and the primary_backup_name attributes of the Switch_partition object in the SDR and run the **Eprimary** and **Eclock** commands. Run the following commands:

  ```
  SDRChangeAttrValues Switch_partition primary_name=none
  SDRChangeAttrValues Switch_partition primary_backup_name=none
  Eprimary new_oncoming_primary_name -backup new_oncoming_backup_name
  Eclock -d
  ```

- For an SP Switch2, reset the primary_name and the primary_backup_name attributes of the Switch_plane object in the SDR and run the **Eprimary** command. Run the following commands:

  ```
  SDRChangeAttrValues Switch_plane primary_name=none
  SDRChangeAttrValues Switch_plane primary_backup_name=none
  Eprimary new_oncoming_primary_name -backup new_oncoming_backup_name
  ```

27. Perform a **REBOOT** for each PSSP node. You can do this by using Perspectives or by issuing the **hmcmds** command.

    Follow the proper install sequence by customizing each of the boot server nodes first. After the SP boot/install server node completes the installation setup, you can customize the remaining SP nodes.

    Now verify that the customization was successful on each of the nodes. When customization is complete, you can restart the switch using the **Estart** command.

Performing Tasks in HACWS Configurations

The following additional tasks for HACWS configurations relate to steps 6 through 17 in “Performing Tasks Required on the Control Workstation” on page 586.

Note: Consider deferring the HACWS reconfiguration until your SP system has been properly updated and is stable on the new IP addresses and host names. Also, you need to be familiar with the HACWS information in the *PSSP: Installation and Migration Guide*.

When you are ready to reconfigure HACWS, do the following:

1. Stop daemons. Stop HACMP on both the primary and backup control workstations (this automatically stops all HACWS related daemons).
2. Use **mktcpip**. Manually issue the appropriate **ifconfig** commands to configure the control workstation service addresses (backup CWS) on the primary control workstation. Make sure the host name and IP address are configured on the backup control workstation. If you are using an alias IP address, make the required changes to the **/etc/rc.backup_cw_alias** script.

   Manually vary on the external volume group which contains the **/spdata** file system, and then mount the **/spdata** file system.
3. Update **rc.net**. Make updates to the **/spdata/sys1/hacws/rc.syspar_aliases** file to reference the new alias address used for system partition.
4. Update **SDR_dest_info**. No updates required.
5. Issue **setup_authent**. No updates required.
6. Create the new source master. Update the new SDR source master objects on the backup control workstation as well as the primary control workstation.

```
sdr -spname SP_NAME mksrc new_IP_addr (for each Syspar)
```

You can then start the SDR and hardmon daemons on the primary control workstation.

7. Update the SDR. Update the Frame object to include the host name for the **backup_MACN** using **SDRChangeAttrValues**.

   ```
   SDRChangeAttrValues Frame backup_MACN=backup_CWS_hostname
   ```

   You should also now execute the HACWS installation script **install_hacws** on the primary control workstation.

   ```
   /usr/sbin/hacws/install_hacws -p primary_name  -b backup_name
   -s
   ```

8. Remove the current NIM. No updates required.
9. Update the SDR node objects. No updates required.
10. Reboot.

    To reconfigure the cluster topology, follow the standard HACMP procedures documented in *HACMP: Administration Guide*.

    Verify that the HACWS configuration is properly setup by executing the **/usr/sbin/hacws/hacws_verify** command on the control workstation.

    Also verify that you can properly **fail over** from the control workstation to the backup control workstation.

Verifying that Each Node Acknowledges the Changes

To verify the changes, do the following on each node:

1. After reboot is complete and the SP nodes are customized, verify that the following have the correct IP address and host name specified:
   - The updated SP Ethernet address specified for the SP node

     Ensure that the reliable_hostname attribute is identical to the host name returned by the **host** command for the SP Ethernet IP address of the node. The SP Ethernet is the LAN that connects all SP nodes to the control workstation. For example, if the en0 IP address of a node is 129.40.133.75, and the **host 129.40.133.75** command returns the host name k65n11.ppd.pok.ibm.com, then k65n11.ppd.pok.ibm.com must be the host name in the reliable_hostname attribute of the node object in the SDR.

     If the reliable hostname in the SDR and the hostname do not match, do one of the following:

     – If the SDR is incorrect, repeat steps beginning with 22 on page 590 of Performing Tasks Required on the Control Workstation.

     – If the hostname of the node is incorrect, repeat step 9 on page 585 of Performing Tasks on Each Node on the effected nodes and reboot the nodes.
   - The updated default route and gateway
   - The additional adapters (**css0**, Ethernet, FDDI, and token ring)
   - The host name resolution files (**/etc/hosts**)
   - The **/etc/SDR_dest_info** file points to the control workstation and SDR Syspar IP address.

- The acct_master host name is updated for the NFS export list directory **/var/adm/acct** (SP Accounting)
- The files in the **/etc/ssp** directory *cw_name*, *server_hostname*, *server_name*, and *reliable_hostname*.
- The **/etc/krb.conf**, **/etc/krb.realms**, and **/etc/krb-srvtab** files for Kerberos V4.
- The **/etc/krb5.conf** for DCE.

2. Verify that the following files on the SP nodes reflect the updated IP addresses and host names:
   - **/etc/filesystems**
   - **/etc/ntp.conf**
   - **/etc/resolv.conf**
   - **.rhosts in the root user's home directory** for standard AIX
   - **.klogin in the root user's home directory** for Kerberos V4
   - **.k5login in the root user's home directory** for Kerberos V5

   If any of the files are incorrect, make the proper updates for the correct IP address or host name.
3. Verify that the SP security configuration is properly set. Use the commands:
```
/usr/lpp/ssp/bin/splstdata -p      (security settings of Syspar)
/bin/lsauthent                     (local authentication setting)
/bin/lsauthts                      (local SP trusted service setting)
```
4. Verify that the NIM resources were built on the PSSP boot server nodes by executing the **lsnim** command. If there were NIM problems, remove the current NIM database and configuration files.
```
/usr/lpp/ssp/bin/delnimmast -l node_number
```
   Then issue **setup_server** on the PSSP boot server node.
5. Verify that the RSCT services have been activated on the PSSP nodes. Execute **lssrc -a** command to list all the active subsystems.
```
/bin/lssrc -a | grep rsct_susbsystem
```
   If you suspect that any of the expected RSCT services are inoperative or not available on the SP node, it is best to remove and then add the RSCT services using the **syspar_ctrl** command:
```
/usr/lpp/ssp/bin/syspar_ctrl -c
/usr/lpp/ssp/bin/syspar_ctrl -A
```
6. Reconfigure and start the IBM Virtual Shared Disk for the SP nodes that support the IBM Virtual Shared Disk configuration. You can do this easily for all nodes by using the IBM Virtual Shared Disk Perspective. If you are implementing a script, you might prefer to issue the following commands on each node:
```
/usr/lpp/csd/bin/cfgvsd -a
/usr/lpp/csd/bin/startvsd -a
```
   You can validate that the IP address and host names are correctly specified by issuing the following command:
```
/usr/lpp/csd/bin/vsdatalst -n
```

7. If there were modifications made to any SP node system files, reboot the PSSP nodes to reflect the IP address and host name changes. When the SP nodes are initialized, your SP system should be activated using the new IP addresses and host names.

Appendix G. Tolerating IPv6 Alias Addresses

The PSSP software requires that the SP and clustered enterprise server systems use Internet Protocol Version 4 (IPv4) for all interface addresses. IPv6 is a version of the Internet Protocol that extends addressing capability. IPv6 has been in a research and experimental stage in various pockets of the industry. Because of this interest and to prepare for future development, most PSSP 3.2 components can tolerate IPv6 alias addresses coexisting with the required IPv4 network addresses for Ethernet and Token Ring interfaces only. Understand and keep in mind that none of the PSSP software components actually use IPv6 addresses. ***Do not add IPv6 aliases if your system uses an SP switch, runs any level earlier than PSSP 3.2, or uses the DCE, HACWS, or HACMP LPP. Those products do not tolerate IPv6 aliases.***

You might have your own research and experimental projects and goals for using IPv6. If your system environment is free of all IPv6–intolerant components and you have the knowledge and experience to sustain such a system independently, you might be able to add IPv6 aliases for the IPv4 addresses on Ethernet or Token Ring network interfaces.

If under those conditions you still want to add IPv6 aliases, be certain to carefully read and understand the information concerning IPv6 in the publications for each IBM LPP on your system. Several ways of adding IPv6 alias addresses might put the availability and serviceability of your system at risk. IBM suggests you use the **chdev** command to safely add and delete IPv6 aliases for IPv4 addresses.

Adding an IPv6 Alias

To add an IPv6 alias for an IPv4 address, use the **chdev** command of AIX. For example, to add the IPv6 alias address `fe80::60:8cff:fee8:618b` to the interface named `en0`, run the following command:

```
chdev -l en0 -a alias6=fe80::60:8cff:fee8:618b
```

Deleting an IPv6 Alias

To remove an IPv6 alias of an IPv4 address, use the **chdev** command of AIX. For example, to remove the IPv6 alias address `fe80::60:8cff:fee8:618b` from the interface named `en0`, run the following command:

```
chdev -l en0 -a delalias6=fe80::60:8cff:fee8:618b
```

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Publicly Available Software

PSSP includes software that is publicly available:

expect	Programmed dialogue with interactive programs
Perl	Practical Extraction and Report Language
SUP	Software Update Protocol
Tcl	Tool Command Language
TclX	Tool Command Language Extended
Tk	Tcl-based Tool Kit for X-windows

This book discusses the use of these products only as they apply specifically to the RS/6000 SP system. The distribution for these products includes the source code and associated documentation. **/usr/lpp/ssp/public** contains the compressed **tar** files of the publicly available software. (IBM has made minor modifications to the versions of Tcl and Tk used in the SP system to improve their security characteristics. Therefore, the IBM-supplied versions do not match exactly the versions you may build from the compressed **tar** files.) All copyright notices in the documentation must be respected. You can find version and distribution information for each of these products that are part of your selected install options in the
| **/usr/lpp/ssp/READMES/ssp.public.README** file.

| ## Software Update Protocol

| IBM has provided modifications to this software. The
| resulting software is provided to you on an “AS IS”
| basis and WITHOUT WARRANTY OF ANY KIND,
| WHETHER EXPRESS OR IMPLIED, INCLUDING THE
| IMPLIED WARRANTIES OF MERCHANTABILITY AND
| FITNESS FOR A PARTICULAR PURPOSE.

Glossary of Terms and Abbreviations

A

| **ACL**. Access Control List. A list that defines who has permission to access certain services; that is, for whom a server may perform certain tasks. This is usually a list of principals with the type of access assigned to each.

adapter. An adapter is a mechanism for attaching parts. For example, an adapter could be a part that electrically or physically connects a device to a computer or to another device. In the SP system, network connectivity is supplied by various adapters, some optional, that can provide connection to I/O devices, networks of workstations, and mainframe networks. Ethernet, FDDI, token-ring, HiPPI, SCSI, FCS, and ATM are examples of adapters that can be used as part of an SP system.

address. A character or group of characters that identifies a register, a device, a particular part of storage, or some other data source or destination.

AFS. A distributed file system that provides authentication services as part of its file system creation.

AIX. Abbreviation for Advanced Interactive Executive, IBM's licensed version of the UNIX operating system. AIX is particularly suited to support technical computing applications, including high function graphics and floating point computations.

Amd. Berkeley Software Distribution automount daemon.

API. Application Programming Interface. A set of programming functions and routines that provide access between the Application layer of the OSI seven-layer model and applications that want to use the network. It is a software interface.

application. The use to which a data processing system is put; for example, a payroll application, an airline reservation application.

application data. The data that is produced using an application program.

ARP. Address Resolution Protocol.

ATM. Asynchronous Transfer Mode. (See *TURBOWAYS 100 ATM Adapter.*)

authentication. The process of validating the identity of either a user of a service or the service itself. The process of a principal proving the authenticity of its identity.

| **authorization**. The process of obtaining permission to access resources or perform tasks. In SP security services, authorization is based on the principal identifier. The granting of access rights to a principal.

| **authorization file**. A type of ACL (access control list) used by the IBM AIX remote commands and the IBM PSSP Sysctl and Hardmon components.

B

batch processing. (1) The processing of data or the accomplishment of jobs accumulated in advance in such a manner that each accumulation thus formed is processed or accomplished in the same run. (2) The processing of data accumulating over a period of time. (3) Loosely, the execution of computer programs serially. (4) Computer programs executed in the background.

BMCA. Block Multiplexer Channel Adapter. The block multiplexer channel connection allows the RS/6000 to communicate directly with a host System/370 or System/390; the host operating system views the system unit as a control unit.

BOS. The AIX Base Operating System.

C

call home function. The ability of a system to call the IBM support center and open a PMR to have a repair scheduled.

CDE. Common Desktop Environment. A graphical user interface for UNIX.

charge feature. An optional feature for either software or hardware for which there is a charge.

CLI. Command Line Interface.

client. (1) A function that requests services from a server and makes them available to the user. (2) A term used in an environment to identify a machine that uses the resources of the network.

Client Input/Output Sockets (CLIO/S). A software package that enables high-speed data and tape access between SP systems, AIX systems, and ES/9000 mainframes.

CLIO/S. Client Input/Output Sockets.

CMI. Centralized Management Interface provides a series of SMIT menus and dialogues used for defining and querying the SP system configuration.

| **Concurrent Virtual Shared Disk**. A virtual shared disk that can be concurrently accessed by more than one server.

connectionless. A communication process that takes place without first establishing a connection.

connectionless network. A network in which the sending logical node must have the address of the receiving logical node before information interchange can begin. The packet is routed through nodes in the network based on the destination address in the packet. The originating source does not receive an acknowledgment that the packet was received at the destination.

control workstation. A single point of control allowing the administrator or operator to monitor and manage the SP system using the IBM AIX Parallel System Support Programs.

| **credentials**. A protocol message, or part thereof, containing a ticket and an authenticator supplied by a client and used by a server to verify the client's identity.

css. Communication subsystem.

D

daemon. A process, not associated with a particular user, that performs system-wide functions such as administration and control of networks, execution of time-dependent activities, line printer spooling and so forth.

DASD. Direct Access Storage Device. Storage for input/output data.

DCE. Distributed Computing Environment.

DFS. distributed file system. A subset of the IBM Distributed Computing Environment.

DNS. Domain Name Service. A hierarchical name service which maps high level machine names to IP addresses.

E

Error Notification Object. An object in the SDR that is matched with an error log entry. When an error log entry occurs that matches the Notification Object, a user-specified action is taken.

ESCON. Enterprise Systems Connection. The ESCON channel connection allows the RS/6000 to communicate directly with a host System/390; the host operating system views the system unit as a control unit.

Ethernet. (1) Ethernet is the standard hardware for TCP/IP local area networks in the UNIX marketplace. It is a 10-megabit per second baseband type LAN that allows multiple stations to access the transmission medium at will without prior coordination, avoids contention by using carrier sense and deference, and resolves contention by collision detection (CSMA/CD). (2) A passive coaxial cable whose interconnections contain devices or components, or both, that are all active. It uses CSMA/CD technology to provide a best-effort delivery system.

Ethernet network. A baseband LAN with a bus topology in which messages are broadcast on a coaxial cabling using the carrier sense multiple access/collision detection (CSMA/CD) transmission method.

event. In Event Management, the notification that an expression evaluated to true. This evaluation occurs each time an instance of a resource variable is observed.

expect. Programmed dialogue with interactive programs.

expression. In Event Management, the relational expression between a resource variable and other elements (such as constants or the previous value of an instance of the variable) that, when true, generates an event. An example of an expression is `X < 10` where X represents the resource variable `IBM.PSSP.aixos.PagSp.%totalfree` (the percentage of total free paging space). When the expression is true, that is, when the total free paging space is observed to be less than 10%, the Event Management subsystem generates an event to notify the appropriate application.

F

failover. Also called fallover, the sequence of events when a primary or server machine fails and a secondary or backup machine assumes the primary workload. This is a disruptive failure with a short recovery time.

fall back. Also called fallback, the sequence of events when a primary or server machine takes back control of its workload from a secondary or backup machine.

FDDI. Fiber Distributed Data Interface.

| **FFDC**. First Failure Data Capture.

Fiber Distributed Data Interface (FDDI). An American National Standards Institute (ANSI) standard for 100-megabit-per-second LAN using optical fiber cables. An FDDI local area network (LAN) can be up to 100 km (62 miles) and can include up to 500 system units. There can be up to 2 km (1.24 miles) between system units and concentrators.

file. A set of related records treated as a unit, for example, in stock control, a file could consist of a set of invoices.

file name. A CMS file identifier in the form of 'filename filetype filemode' (like: TEXT DATA A).

file server. A centrally located computer that acts as a storehouse of data and applications for numerous users of a local area network.

File Transfer Protocol (FTP). The Internet protocol (and program) used to transfer files between hosts. It is an application layer protocol in TCP/IP that uses TELNET and TCP protocols to transfer bulk-data files between machines or hosts.

| **First Failure Data Capture (FFDC)**. A set of utilities
| used for recording persistent records of failures and
| significant software incidents. It provides a means of
| associating failures to one another, thus allowing
| software to link effects of a failure to their causes and
| thereby facilitating discovery of the root cause of a
| failure.

foreign host. Any host on the network other than the local host.

FTP. File transfer protocol.

G

gateway. An intelligent electronic device interconnecting dissimilar networks and providing protocol conversion for network compatibility. A gateway provides transparent access to dissimilar networks for nodes on either network. It operates at the session presentation and application layers.

H

HACMP. High Availability Cluster Multi-Processing for AIX.

HACWS. High Availability Control Workstation function, based on HACMP, provides for a backup control workstation for the SP system.

HAL. Hardware Abstraction Layer, a communication device interface that provides communication channels for processes.

Hashed Shared Disk (HSD). The data striping device for the IBM Virtual Shared Disk. The device driver lets application programs stripe data across physical disks in multiple IBM Virtual Shared Disks, thus reducing I/O bottlenecks.

help key. In the SP graphical interface, the key that gives you access to the SP graphical interface help facility.

High Availability Cluster Multi-Processing. An IBM facility to cluster nodes or components to provide high availability by eliminating single points of failure.

HiPPI. High Performance Parallel Interface. RS/6000 units can attach to a HiPPI network as defined by the ANSI specifications. The HiPPI channel supports burst rates of 100 Mbps over dual simplex cables; connections can be up to 25 km in length as defined by the standard and can be extended using third-party HiPPI switches and fiber optic extenders.

home directory. The directory associated with an individual user.

host. A computer connected to a network, and providing an access method to that network. A host provides end-user services.

I

instance vector. Obsolete term for resource identifier.

Intermediate Switch Board. Switches mounted in the switch expansion frame.

Internet. A specific inter-network consisting of large national backbone networks such as APARANET, MILNET, and NSFnet, and a myriad of regional and campus networks all over the world. The network uses the TCP/IP protocol suite.

Internet Protocol (IP). (1) A protocol that routes data through a network or interconnected networks. IP acts as an interface between the higher logical layers and the physical network. This protocol, however, does not provide error recovery, flow control, or guarantee the reliability of the physical network. IP is a connectionless protocol. (2) A protocol used to route data from its source to it destination in an Internet environment.

IP address. A 32-bit address assigned to devices or hosts in an IP internet that maps to a physical address. The IP address is composed of a network and host portion.

ISB. Intermediate Switch Board.

K

Kerberos. A service for authenticating users in a network environment.

kernel. The core portion of the UNIX operating system which controls the resources of the CPU and allocates them to the users. The kernel is memory-resident, is said to run in "kernel mode" and is protected from user tampering by the hardware.

| **Kernel Low-Level Application Programming
| Interface (KLAPI)**. KLAPI provides transport service
| for communication using the SP Switch.

L

LAN. (1) Acronym for Local Area Network, a data network located on the user's premises in which serial transmission is used for direct data communication among data stations. (2) Physical network technology that transfers data a high speed over short distances. (3) A network in which a set of devices is connected to another for communication and that can be connected to a larger network.

local host. The computer to which a user's terminal is directly connected.

log database. A persistent storage location for the logged information.

log event. The recording of an event.

log event type. A particular kind of log event that has a hierarchy associated with it.

logging. The writing of information to persistent storage for subsequent analysis by humans or programs.

M

mask. To use a pattern of characters to control retention or elimination of portions of another pattern of characters.

menu. A display of a list of available functions for selection by the user.

Motif. The graphical user interface for OSF, incorporating the X Window System. Also called OSF/Motif.

MTBF. Mean time between failure. This is a measure of reliability.

MTTR. Mean time to repair. This is a measure of serviceability.

N

naive application. An application with no knowledge of a server that fails over to another server. Client to server retry methods are used to reconnect.

network. An interconnected group of nodes, lines, and terminals. A network provides the ability to transmit data to and receive data from other systems and users.

NFS. Network File System. NFS allows different systems (UNIX or non-UNIX), different architectures, or vendors connected to the same network, to access remote files in a LAN environment as though they were local files.

NIM. Network Installation Management is provided with AIX to install AIX on the nodes.

NIM client. An AIX system installed and managed by a NIM master. NIM supports three types of clients:

- Standalone
- Diskless
- Dataless

NIM master. An AIX system that can install one or more NIM clients. An AIX system must be defined as a NIM master before defining any NIM clients on that system. A NIM master managers the configuration database containing the information for the NIM clients.

NIM object. A representation of information about the NIM environment. NIM stores this information as objects in the NIM database. The types of objects are:

- Network
- Machine
- Resource

NIS. Network Information System.

node. In a network, the point where one or more functional units interconnect transmission lines. A computer location defined in a network. The SP system can house several different types of nodes for both serial and parallel processing. These node types can include thin nodes, wide nodes, 604 high nodes, as well as other types of nodes both internal and external to the SP frame.

Node Switch Board. Switches mounted on frames that contain nodes.

NSB. Node Switch Board.

NTP. Network Time Protocol.

O

ODM. Object Data Manager. In AIX, a hierarchical object-oriented database for configuration data.

P

parallel environment. A system environment where message passing or SP resource manager services are used by the application.

Parallel Environment. A licensed IBM program used for message passing applications on the SP or RS/6000 platforms.

parallel processing. A multiprocessor architecture which allows processes to be allocated to tightly coupled multiple processors in a cooperative processing environment, allowing concurrent execution of tasks.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (2) An item in a menu for which the operator specifies a value or for which the system provides a value when the menu is interpreted. (3) A name in a procedure that is used to refer to an argument that is passed to the procedure. (4) A particular piece of information that a system or application program needs to process a request.

partition. See system partition.

Perl. Practical Extraction and Report Language.

perspective. The primary window for each SP Perspectives application, so called because it provides a unique view of an SP system.

pipe. A UNIX utility allowing the output of one command to be the input of another. Represented by the | symbol. It is also referred to as filtering output.

PMR. Problem Management Report.

POE. Formerly Parallel Operating Environment, now Parallel Environment for AIX.

port. (1) An end point for communication between devices, generally referring to physical connection. (2) A 16-bit number identifying a particular TCP or UDP resource within a given TCP/IP node.

predicate. Obsolete term for expression.

Primary node or machine. (1) A device that runs a workload and has a standby device ready to assume the primary workload if that primary node fails or is taken out of service. (2) A node on the switch that initializes, provides diagnosis and recovery services, and performs other operations to the switch network. (3) In IBM Virtual Shared Disk function, when physical disks are connected to two nodes (twin-tailed), one node is designated as the primary node for each disk and the other is designated the secondary, or backup, node. The primary node is the server node for IBM Virtual Shared Disks defined on the physical disks under normal conditions. The secondary node can become the server node for the disks if the primary node is unavailable (off-line or down).

Problem Management Report. The number in the IBM support mechanism that represents a service incident with a customer.

process. (1) A unique, finite course of events defined by its purpose or by its effect, achieved under defined conditions. (2) Any operation or combination of operations on data. (3) A function being performed or waiting to be performed. (4) A program in operation. For example, a daemon is a system process that is always running on the system.

protocol. A set of semantic and syntactic rules that defines the behavior of functional units in achieving communication.

R

RAID. Redundant array of independent disks.

rearm expression. In Event Management, an expression used to generate an event that alternates with an original event expression in the following way: the event expression is used until it is true, then the rearm expression is used until it is true, then the event expression is used, and so on. The rearm expression is commonly the inverse of the event expression (for example, a resource variable is on or off). It can also be used with the event expression to define an upper and lower boundary for a condition of interest.

rearm predicate. Obsolete term for rearm expression.

remote host. *See foreign host*.

resource. In Event Management, an entity in the system that provides a set of services. Examples of resources include hardware entities such as processors, disk drives, memory, and adapters, and software entities such as database applications, processes, and file systems. Each resource in the system has one or more attributes that define the state of the resource.

resource identifier. In Event Management, a set of elements, where each element is a name/value pair of the form `name=value`, whose values uniquely identify the copy of the resource (and by extension, the copy of the resource variable) in the system.

resource monitor. A program that supplies information about resources in the system. It can be a command, a daemon, or part of an application or subsystem that manages any type of system resource.

resource variable. In Event Management, the representation of an attribute of a resource. An example of a resource variable is `IBM.AIX.PagSp.%totalfree`, which represents the percentage of total free paging space. `IBM.AIX.PagSp` specifies the resource name and `%totalfree` specifies the resource attribute.

RISC. Reduced Instruction Set Computing (RISC), the technology for today's high performance personal computers and workstations, was invented in 1975. Uses a small simplified set of frequently used instructions for rapid execution.

rlogin (remote LOGIN). A service offered by Berkeley UNIX systems that allows authorized users of one machine to connect to other UNIX systems across a network and interact as if their terminals were connected directly. The rlogin software passes information about the user's environment (for example, terminal type) to the remote machine.

RPC. Acronym for Remote Procedure Call, a facility that a client uses to have a server execute a procedure call. This facility is composed of a library of procedures plus an XDR.

RSH. A variant of RLOGIN command that invokes a command interpreter on a remote UNIX machine and passes the command line arguments to the command interpreter, skipping the LOGIN step completely. See also *rlogin*.

S

SCSI. Small Computer System Interface.

Secondary node. In IBM Virtual Shared Disk function, when physical disks are connected to two nodes (twin-tailed), one node is designated as the primary node for each disk and the other is designated as the secondary, or backup, node. The secondary node acts as the server node for the IBM Virtual Shared disks defined on the physical disks if the primary node is unavailable (off-line or down).

server. (1) A function that provides services for users. A machine may run client and server processes at the same time. (2) A machine that provides resources to the network. It provides a network service, such as disk storage and file transfer, or a program that uses such a service. (3) A device, program, or code module on a network dedicated to providing a specific service to a network. (4) On a LAN, a data station that provides facilities to other data stations. Examples are file server, print server, and mail server.

shell. The shell is the primary user interface for the UNIX operating system. It serves as command language interpreter, programming language, and allows foreground and background processing. There are three different implementations of the shell concept: Bourne, C and Korn.

Small Computer System Interface (SCSI). An input and output bus that provides a standard interface for the attachment of various direct access storage devices (DASD) and tape drives to the RS/6000.

Small Computer Systems Interface Adapter (SCSI Adapter). An adapter that supports the attachment of various direct-access storage devices (DASD) and tape drives to the RS/6000.

SMIT. The System Management Interface Toolkit is a set of menu driven utilities for AIX that provides functions such as transaction login, shell script creation, automatic updates of object database, and so forth.

SNMP. Simple Network Management Protocol. (1) An IP network management protocol that is used to monitor attached networks and routers. (2) A TCP/IP-based protocol for exchanging network management information and outlining the structure for communications among network devices.

socket. (1) An abstraction used by Berkeley UNIX that allows an application to access TCP/IP protocol functions. (2) An IP address and port number pairing. (3) In TCP/IP, the Internet address of the host computer on which the application runs, and the port number it uses. A TCP/IP application is identified by its socket.

standby node or machine. A device that waits for a failure of a primary node in order to assume the identity of the primary node. The standby machine then runs the primary's workload until the primary is back in service.

subnet. Shortened form of subnetwork.

subnet mask. A bit template that identifies to the TCP/IP protocol code the bits of the host address that are to be used for routing for specific subnetworks.

subnetwork. Any group of nodes that have a set of common characteristics, such as the same network ID.

subsystem. A software component that is not usually associated with a user command. It is usually a daemon process. A subsystem will perform work or provide services on behalf of a user request or operating system request.

SUP. Software Update Protocol.

switch capsule. A group of SP frames consisting of a switched frame and its companion non-switched frames.

Sysctl. Secure System Command Execution Tool. An authenticated client/server system for running commands remotely and in parallel.

syslog. A BSD logging system used to collect and manage other subsystem's logging data.

System Administrator. The user who is responsible for setting up, modifying, and maintaining the SP system.

system partition. A group of nonoverlapping nodes on a switch chip boundary that act as a logical SP system.

T

tar. Tape ARchive, is a standard UNIX data archive utility for storing data on tape media.

TaskGuides. SP TaskGuides are a form of advanced online assistance designed to walk you through complex or infrequently performed tasks. Each TaskGuide does not simply list the required steps. It actually performs the steps for you, automating the steps to the highest degree possible and prompting you for input only when absolutely necessary. You might recognize them as *wizards*.

Tcl. Tool Command Language.

TclX. Tool Command Language Extended.

TCP. Acronym for Transmission Control Protocol, a stream communication protocol that includes error recovery and flow control.

TCP/IP. Acronym for Transmission Control Protocol/Internet Protocol, a suite of protocols designed to allow communication between networks regardless of the technologies implemented in each network. TCP provides a reliable host-to-host protocol between hosts in packet-switched communications networks and in interconnected systems of such networks. It assumes that the underlying protocol is the Internet Protocol.

Telnet. Terminal Emulation Protocol, a TCP/IP application protocol that allows interactive access to foreign hosts.

| **ticket**. An encrypted protocol message used to
| securely pass the identity of a user from a client to a
| server.

Tk. Tcl-based Tool Kit for X Windows.

TMPCP. Tape Management Program Control Point.

token-ring. (1) Network technology that controls media access by passing a token (special packet or frame) between media-attached machines. (2) A network with a ring topology that passes tokens from one attaching device (node) to another. (3) The IBM Token-Ring LAN connection allows the RS/6000 system unit to participate in a LAN adhering to the IEEE 802.5 Token-Passing Ring standard or the ECMA standard 89 for Token-Ring, baseband LANs.

transaction. An exchange between the user and the system. Each activity the system performs for the user is considered a transaction.

transceiver (transmitter-receiver). A physical device that connects a host interface to a local area network, such as Ethernet. Ethernet transceivers contain electronics that apply signals to the cable and sense collisions.

transfer. To send data from one place and to receive the data at another place. Synonymous with move.

transmission. The sending of data from one place for reception elsewhere.

TURBOWAYS 100 ATM Adapter. An IBM high-performance, high-function intelligent adapter that provides dedicated 100 Mbps ATM (asynchronous transfer mode) connection for high-performance servers and workstations.

U

UDP. User Datagram Protocol.

UNIX operating system. An operating system developed by Bell Laboratories that features multiprogramming in a multiuser environment. The UNIX operating system was originally developed for use on minicomputers, but has been adapted for mainframes and microcomputers. **Note:** The AIX operating system is IBM's implementation of the UNIX operating system.

user. Anyone who requires the services of a computing system.

User Datagram Protocol (UDP). (1) In TCP/IP, a packet-level protocol built directly on the Internet Protocol layer. UDP is used for application-to-application programs between TCP/IP host systems. (2) A transport protocol in the Internet suite of protocols that provides unreliable, connectionless datagram service. (3) The Internet Protocol that enables an application programmer on one machine or process to send a datagram to an application program on another machine or process.

user ID. A nonnegative integer, contained in an object of type *uid_t*, that is used to uniquely identify a system user.

V

Virtual Shared Disk, IBM. The function that allows application programs executing at different nodes of a system partition to access a raw logical volume as if it were local at each of the nodes. In actuality, the logical volume is local at only one of the nodes (the server node).

W

workstation. (1) A configuration of input/output equipment at which an operator works. (2) A terminal or microcomputer, usually one that is connected to a mainframe or to a network, at which a user can perform applications.

X

X Window System. A graphical user interface product.

Bibliography

This bibliography helps you find product documentation related to the RS/6000 SP hardware and software products.

You can find most of the IBM product information for RS/6000 SP products on the World Wide Web. Formats for both viewing and downloading are available.

PSSP documentation is shipped with the PSSP product in a variety of formats and can be installed on your system. The man pages for public code that PSSP includes are also available online.

Finally, this bibliography contains a list of non-IBM publications that discuss parallel computing and other topics related to the RS/6000 SP.

Information Formats

Documentation supporting RS/6000 SP software licensed programs is no longer available from IBM in hardcopy format. However, you can view, search, and print documentation in the following ways:

- On the World Wide Web
- Online (from the product media or the SP Resource Center)

Finding Documentation on the World Wide Web

Most of the RS/6000 SP hardware and software books are available from the IBM RS/6000 Web site at:

http://www.rs6000.ibm.com

You can view a book or download a Portable Document Format (PDF) version of it. At the time this manual was published, the Web address of the "RS/6000 SP Product Documentation Library" page was:

http://www.rs6000.ibm.com/resource/aix_resource/sp_books

However, the structure of the RS/6000 Web site can change over time.

Accessing PSSP Documentation Online

On the same medium as the PSSP product code, IBM ships PSSP man pages, HTML files, and PDF files. In order to use these publications, you must first install the **ssp.docs** file set.

To view the PSSP HTML publications, you need access to an HTML document browser such as Netscape. The HTML files and an index that links to them are installed in the **/usr/lpp/ssp/html** directory. Once installed, you can also view the HTML files from the RS/6000 SP Resource Center.

If you have installed the SP Resource Center on your SP system, you can access it by entering the **/usr/lpp/ssp/bin/resource_center** command. If you have the SP Resource Center on CD-ROM, see the **readme.txt** file for information about how to run it.

To view the PSSP PDF publications, you need access to the Adobe Acrobat Reader. The Acrobat Reader is shipped with the AIX Version 4.3 Bonus Pack and is also freely available for downloading from the Adobe Web site at:

| http://www.adobe.com

To successfully print a large PDF file (approximately 300 or more pages) from the Adobe Acrobat reader, you may need to select the “Download Fonts Once” button on the Print window.

Manual Pages for Public Code

The following manual pages for public code are available in this product:

SUP	/usr/lpp/ssp/man/man1/sup.1
Perl (Version 4.036)	/usr/lpp/ssp/perl/man/perl.man
	/usr/lpp/ssp/perl/man/h2ph.man
	/usr/lpp/ssp/perl/man/s2p.man
	/usr/lpp/ssp/perl/man/a2p.man

Manual pages and other documentation for **Tcl**, **TclX**, **Tk**, and **expect** can be found in the compressed **tar** files located in the **/usr/lpp/ssp/public** directory.

RS/6000 SP Planning Publications

This section lists the IBM product documentation for planning for the IBM RS/6000 SP hardware and software.

IBM RS/6000 SP:

- *Planning, Volume 1, Hardware and Physical Environment*, GA22-7280
- *Planning, Volume 2, Control Workstation and Software Environment*, GA22-7281

RS/6000 SP Hardware Publications

This section lists the IBM product documentation for the IBM RS/6000 SP hardware.

IBM RS/6000 SP:

- *Planning, Volume 1, Hardware and Physical Environment*, GA22-7280
- *Planning, Volume 2, Control Workstation and Software Environment*, GA22-7281
- | *Installation and Relocation*, GA22-7441
- | *System Service Guide*, GA22-7442
- | *SP Switch Service Guide*, GA22-7443
- | *SP Switch2 Service Guide*, GA22-7444
- | *Uniprocessor Node Service Guide*, GA22-7445
- | *604 and 604e SMP High Node Service Guide*, GA22-7446
- | *SMP Thin and Wide Node Service Guide*, GA22-7447
- | *POWER3 SMP High Node Service Guide*, GA22-7448

RS/6000 SP Switch Router Publications

The RS/6000 SP Switch Router is based on the Ascend GRF switched IP router product from Lucent Technologies. You can order the SP Switch Router as the IBM 9077.

The following publications are shipped with the SP Switch Router. You can also order these publications from IBM using the order numbers shown.

- *Ascend GRF GateD Manual*, GA22-7327
- *Ascend GRF 400/1600 Getting Started*, GA22-7368
- *Ascend GRF Configuration and Management*, GA22-7366
- *Ascend GRF Reference Guide*, GA22-7367
- *SP Switch Router Adapter Guide*, GA22-7310

RS/6000 SP Software Publications

This section lists the IBM product documentation for software products related to the IBM RS/6000 SP. These products include:

- IBM Parallel System Support Programs for AIX (PSSP)
- IBM LoadLeveler for AIX (LoadLeveler)
- IBM Parallel Environment for AIX (Parallel Environment)
- IBM General Parallel File System for AIX (GPFS)
- IBM Engineering and Scientific Subroutine Library (ESSL) for AIX
- IBM Parallel ESSL for AIX
- IBM High Availability Cluster Multi-Processing for AIX (HACMP)
- IBM Client Input Output/Sockets (CLIO/S)
- IBM Network Tape Access and Control System for AIX (NetTAPE)

PSSP Publications

IBM RS/6000 SP:

- *Planning, Volume 2, Control Workstation and Software Environment*, GA22-7281

PSSP:

- *Installation and Migration Guide*, GA22-7347
- *Administration Guide*, SA22-7348
- *Managing Shared Disks*, SA22-7349
- *Performance Monitoring Guide and Reference*, SA22-7353
- *Diagnosis Guide*, GA22-7350
- *Command and Technical Reference*, SA22-7351
- *Messages Reference*, GA22-7352

RS/6000 Cluster Technology (RSCT):

- *Event Management Programming Guide and Reference*, SA22-7354
- *Group Services Programming Guide and Reference*, SA22-7355
- *First Failure Data Capture Programming Guide and Reference*, SA22-7454

LoadLeveler Publications

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- *Diagnosis and Messages Guide*, GA22-7277

GPFS Publications

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- *Problem Determination Guide*, GA22-7434
- *Data Management API Guide*, GA22-7435
- *Guide and Reference*, GA22-7452
- *Installation and Tuning Guide*, GA22-7453

Parallel Environment Publications

Parallel Environment:

- *Installation Guide*, GA22-7418
- *Messages*, GA22-7419
- *DPCL Programming Guide*, SA22-7420
- *DPCL Class Reference*, SA22-7421
- *MPI Programming Guide*, SA22-7422
- *MPI Subroutine Reference*, SA22-7423
- *Hitchhiker's Guide*, SA22-7424
- *Operation and Use, Volume 1*, SA22-7425
- *Operation and Use, Volume 2*, SA22-7426
- *MPL Programming and Subroutine Reference*, GC23-3893

Parallel ESSL and ESSL Publications

- *ESSL Products: General Information*, GC23-0529
- *Parallel ESSL: Guide and Reference*, SA22-7273
- *ESSL: Guide and Reference*, SA22-7272

HACMP Publications

HACMP:

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- *Planning Guide*, SC23-4277
- *Installation Guide*, SC23-4278
- *Administration Guide*, SC23-4279
- *Troubleshooting Guide*, SC23-4280
- *Programming Locking Applications*, SC23-4281
- *Programming Client Applications*, SC23-4282
- *Master Index and Glossary*, SC23-4285
- *HANFS for AIX Installation and Administration Guide*, SC23-4283
- *Enhanced Scalability Installation and Administration Guide*, SC23-4284

CLIO/S Publications

CLIO/S:

- *General Information*, GC23-3879
- *User's Guide and Reference*, GC28-1676

NetTAPE Publications

NetTAPE:

- *General Information*, GC23-3990
- *User's Guide and Reference*, available from your IBM representative

AIX and Related Product Publications

For the latest information on AIX and related products, including RS/6000 hardware products, see *AIX and Related Products Documentation Overview*, SC23-2456. You can order a hard copy of the book from IBM. You can also view it online from the “AIX Online Publications and Books” page of the RS/6000 Web site at:

http://www.rs6000.ibm.com/resource/aix_resource/Pubs

DCE Publications

The DCE library consists of the following books:

- *IBM DCE 3.1 for AIX: Administration Commands Reference*
- *IBM DCE 3.1 for AIX: Administration Guide—Introduction*
- *IBM DCE 3.1 for AIX: Administration Guide—Core Components*
- *IBM DCE 3.1 for AIX: DFS Administration Guide and Reference*
- *IBM DCE 3.1 for AIX: Application Development Guide—Introduction and Style Guide*
- *IBM DCE 3.1 for AIX: Application Development Guide—Core Components*
- *IBM DCE 3.1 for AIX: Application Development Guide—Directory Services*
- *IBM DCE 3.1 for AIX: Application Development Reference*
- *IBM DCE 3.1 for AIX: Problem Determination Guide*
- *IBM DCE 3.1 for AIX: Release Notes*

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http://www.ibm.com/software/network/dce/library

Red Books

IBM's International Technical Support Organization (ITSO) has published a number of redbooks related to the RS/6000 SP. For a current list, see the ITSO Web site at:

http://www.redbooks.ibm.com

Non-IBM Publications

Here are some non-IBM publications that you may find helpful.

- Almasi, G., Gottlieb, A., *Highly Parallel Computing*, Benjamin-Cummings Publishing Company, Inc., 1989.
- Foster, I., *Designing and Building Parallel Programs*, Addison-Wesley, 1995.
- Gropp, W., Lusk, E., Skjellum, A., *Using MPI*, The MIT Press, 1994.
- Message Passing Interface Forum, *MPI: A Message-Passing Interface Standard, Version 1.1*, University of Tennessee, Knoxville, Tennessee, June 6, 1995.
- Message Passing Interface Forum, *MPI-2: Extensions to the Message-Passing Interface, Version 2.0*, University of Tennessee, Knoxville, Tennessee, July 18, 1997.
- Ousterhout, John K., *Tcl and the Tk Toolkit*, Addison-Wesley, Reading, MA, 1994, ISBN 0-201-63337-X.
- Pfister, Gregory, F., *In Search of Clusters*, Prentice Hall, 1998.

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