AIX Version 7.1

IBM Workload Partitions for AIX

SC23-6720-00

AIX Version 7.1

IBM Workload Partitions for AIX

SC23-6720-00

Note
Before using this information and the product it supports, read the information in "Notices" on page 35.

First Edition (September 2010)

This edition applies to AIX Version 7.1 and to all subsequent releases and modifications until otherwise indicated in new editions.

Contents

About this document v
Highlighting v
Case-sensitivity in AIX v
ISO 9000. v

IBM Workload Partitions for AIX 1
AIX WPAR concepts 1
Differences in the WPAR environment 1
Restrictions and limitations in the WPAR environment 2
Devices 2
Networking. 3
Global environment 3
Security 4
Resource controls 5
Devices in WPARs 6
Deploying a device 7
Allocating a device 7
Configuring a device in a WPAR 8
Managing file systems for a device 8
System WPARs 9
Shared and non-shared system WPARs 9
File systems for system WPARs 9
Rootvg WPARs 11
Application workload partitions 12
File systems for application WPARs 12
Configuring system WPARs 12
Naming the system WPAR 12
Creating a system WPAR 13
Configuring directories and file systems for system WPARs 15
Configuring networks for system WPARs . . . 17
Configuring resource controls for system WPARs 19
Using specification files for system WPARs . . . 20
Using an `image.data` file for system WPARs . . 20
Configuring application WPARs 21
Creating an application WPAR 21
Configuring directories and file systems for application WPARs 22
Configuring networks for application WPARs . . 22
Configuring resource controls for application WPARs 23
Working with specification files for application WPARs 23
Administering WPARs. 24
Listing WPARs 24
Listing WPAR identifiers 24
Logging in to a WPAR. 25
Backing up WPARs. 25
Restoring WPARs 26
Removing WPARs 26
Starting system WPARs 26
Stopping WPARs 26
Using the Advanced Accounting subsystem with WPARs 27
Recovering incompatible detached Workload Partitions 27
Managing software with detached workload partitions 28
Using the trace facility with WPARs 29
Making software available to other WPARs. . . . 29
Example: Installing Apache in a WPAR 30
Modified and enhanced AIX commands for WPARs 30

Notices 35
Trademarks 37

Index 39

About this document

Workload partitions (WPARs) are a virtualized operating system environment within a single instance of the AIX® operating system. WPARs secure and isolate the environment for the processes and signals that are used by enterprise applications. This topic explains how to create and manage WPARs on AIX.

Highlighting

The following highlighting conventions are used in this book:

Bold	Identifies commands, subroutines, keywords, files, structures, directories, and other items whose names are predefined by the system. Also identifies graphical objects such as buttons, labels, and icons that the user selects.
Italics	Identifies parameters whose actual names or values are to be supplied by the user.
`Monospace`	Identifies examples of specific data values, examples of text similar to what you might see displayed, examples of portions of program code similar to what you might write as a programmer, messages from the system, or information you should actually type.

Case-sensitivity in AIX

Everything in the AIX operating system is case-sensitive, which means that it distinguishes between uppercase and lowercase letters. For example, you can use the **ls** command to list files. If you type `LS`, the system responds that the command `is not found`. Likewise, **FILEA**, **FiLea**, and **filea** are three distinct file names, even if they reside in the same directory. To avoid causing undesirable actions to be performed, always ensure that you use the correct case.

ISO 9000

ISO 9000 registered quality systems were used in the development and manufacturing of this product.

IBM Workload Partitions for AIX

Workload partitions (WPARs) are virtualized operating system environments within a single instance of the AIX operating system. WPARs secure and isolate the environment for the processes and signals that are used by enterprise applications.

To view or download the PDF version of this topic, select IBM Workload Partitions for AIX.

Downloading Adobe Reader: You need Adobe® Reader installed on your system to view or print this PDF. You can download a free copy from the Adobe website (www.adobe.com/products/acrobat/readstep.html).

AIX WPAR concepts

The WPAR environment is somewhat different from the standard AIX operating system environment. Various aspects of the system, such as networking and resource controls, function differently in the WPAR environment.

Differences in the WPAR environment

While the WPAR environment is similar to the environment for an application on a stand-alone system, there are differences that some applications will recognize.

Applications might recognize differences in the following areas:

Device access
Some devices are accessible within a WPAR by default. Storage devices may be mounted as file systems from the global environment into the WPAR or they can be exported to the WPAR so that file systems can be created/mounted/removed from within the WPAR. Storage device adapters may also be exported to a WPAR, giving the WPAR complete control over configuring devices for that adapter.

Default privilege
The WPAR root user does not have the same level of access as the root user in the global environment by default.

Shared kernel
For applications that provide kernel extensions, the user-level application execution environment is compartmentalized between WPAR instances. However, the shared kernel recognizes all WPAR instances and must maintain the compartmentalization.

Statistic and tuning virtualization
While several AIX system utilities have been enabled to work either fully or partially in a WPAR, there are some utilities that work only in the global environment (for example, the **mpstat** utility and the **sar** utility). Because all WPAR instances share the same kernel and certain kernel subsystems are optimized for system-wide usage, it is not possible to tune all kernel subsystem parameters from a WPAR.

Network configuration
You cannot modify the network configuration (for example, addresses and routes) inside a WPAR. The default configuration of a WPAR prevents applications from using any kind of raw sockets, but system administrators can enable them.

Restrictions and limitations in the WPAR environment

This section lists the restriction and limitations in the WPAR environment.

The following functionality is unavailable within a WPAR:

- PowerHA™
- RSCT
- NFS Server
- WLM controls
- WPAR management
- Kernel tuning

If the WPAR Manager licensed program is installed, there are additional restrictions on WPARs which are enabled for live mobility:

- The WPAR must either be a rootvg WPAR or NFS-based.
- The WPAR cannot have kerberos-protected NFS mounts.
- DMAPI cannot be used within the WPAR.
- Applications within the WPAR cannot use raw logical volume or disks.
- Applications cannot open accessing `/dev/mem or /dev/kmem`.
- The WPAR cannot have kernel extensions exported to them.
- Files which have been mapped cannot be unlinked at the time of mobility.
- Processes cannot have stopped/debugged threads at the time of mobility.
- Processes which have been launched from the **clogin** command cannot exist at the time of mobility.
- See additional restrictions for Compatibility Testing for Application Mobility.

Related information

Restrictions and limitations within a versioned WPAR

Devices

To function properly, some applications require the use of system devices.

You can export a limited set of devices or storage adapters to one or more partitions. Devices that can be exported include Fibre-Channel attached storage devices such as SCSI disk, CD, and tape devices. Applications that require access to non-exportable devices are restricted to running in the global environment. The following pseudo devices are exported to WPARs by default:

- `/dev/audit`
- `/dev/clone`
- `/dev/console`
- `/dev/error`
- `/dev/errorctl`
- `/dev/null`
- `/dev/nvram`
- `/dev/random`
- `/dev/sad`
- `/dev/tty`
- `/dev/urandom`
- `/dev/xti/tcp`
- `/dev/xti/tcp6`
- `/dev/xti/udp`

- /dev/xti/udp6
- /dev/xti/unixdg
- /dev/xti/unixst
- /dev/zero

Devices that are exported to workload portions must operate safely and securely in the WPAR environment.

Related concepts

"Devices in WPARs" on page 6
Different types of devices are supported by the AIX operating system, although the initial support of devices in the WPAR is limited to fiber-attached storage devices, fiber channel adaptors, and virtual Small Computer System Interface (SCSI) disks.

Networking

A WPAR can have one or more network addresses assigned to support network login and network services.

You must have the following information to configure networking:

- The name of the global network interface (for example, en0, en1, et0, or et1) to associate with the address. In the global environment, the IP address assigned to a WPAR appears as an alias address associated with this interface.
- The IPv4 or IPv6 address to assign to the partition.
- The network mask for IPv4 addresses or prefix length for IPv6 addresses to apply to define the local subnet.

If the name of the WPAR resolves to a network address, that address is used as the default network address for the WPAR. You can create a WPAR with no network addresses assigned. In this case, the only external mechanism to access the partition is the **clogin** command from the global environment. The **clogin** command provides a limited function terminal to access the WPAR. It is suggested that WPARs be configured to at least have a private network configured from the global environment so that a network login function such as rlogin or telnet can be used to access the WPAR.

Related tasks

"Configuring networks for system WPARs" on page 17
You can configure the network for a system WPAR using the **-h** flag or the **-N** flag for the **mkwpar** command or the **chwpar** command.

"Configuring networks for application WPARs" on page 22
You can configure the network for an application WPAR using the **-h** flag and the **-N** flag for the **wparexec** command or the **chwpar** command.

Global environment

The global environment has an all-encompassing view of processes, IPC, file systems, devices, and other user-level objects and system-level objects within an AIX system.

This environment allows you to view and interact with processes, file systems and other system components that are assigned to an active WPAR on the system. The global environment is the same as the traditional AIX login environment.

You can create new WPARs only in the global environment. You cannot create new WPARs in other WPARs. Many administrative tasks can be performed only from the global environment. Many commands also behave differently when they are run in the global environment than they do in the WPAR environment.

Security

WPARs provide an isolated application environment that minimizes potential interactions with system objects or processes outside the WPAR. Even though a WPAR is using the same operating system instance as other WPARs or the global environment, the ability to view or interact with processes or devices outside the partition is limited.

In system workload partitions, the ability to interact with the global environment's file systems is limited. For non-persistent system objects, such as IPC and processes, constraints are implemented in the following ways:

- Marking system objects as being owned by an individual WPAR
- Denying users or applications in one WPAR the ability to view or interact with system objects owned by other WPARs

Interaction with persistent objects, such as files and devices, is also limited by maintaining separate file systems local to an individual partition. For persistent objects, constraints are implemented in the following ways:

- Creating and mounting unique file systems separate from file systems available in other WPARs
- Mounting shared, read-only file systems using the **namefs** mount type from the global environment
- Maintaining an environment within the local file system mounts for all processes using the **chroot** command

WPAR isolation

System WPARs and application WPARs are isolated from other partitions. Users cannot subvert the isolation constraints.

WPAR isolation limits the operating environment in the following ways:

- Default configuration of only certain pseudo devices in the `/dev` directory
- Removal of devices, such as `/dev/mem` and `/dev/kmem`, that give a more global view of the system
- Modified behavior of both the reboot command and the halt command to reboot or halt the only the specified systemWPAR, not the entire system

WPAR isolation also prevents users from performing the following administrative tasks:

- Adjusting the system clock
- Manipulating process accounting
- Binding processes to a specific processor
- Exceeding certain system limits, even by privileged users
- Using fine grain timers less than 10 milliseconds
- Manipulating certain machine-level serviceability tools
- Loading or unloading system-level device drivers or kernel extensions
- Manipulating system paging space and certain system-level tuning parameters
- Using certain file system-level operations, such as extension, contraction, or defragmentation

System workload partitions are integrated with the AIX RBAC system, so each system workload partition can have security privileges assigned. The settings are not applicable for application workload partitions.

Note: Workload partition isolation can also constrain the use of computational resources, such as system memory and processor processing time.

Resource controls

WPARs support up to 8192 resource-controlled workload partitions. The number of non-resource-controlled WPARs that can be created is constrained only by the availability of global environment memory and disk space resources. However, a maximum of 8192 can be active at any time.

You can change the resource controls for a WPAR dynamically using the **chwpar** command. If the process or thread limit is reduced on an active WPAR, processes or threads are not terminated, but new process or thread creation is not allowed until the total count falls below the specified limit. For example, if a WPAR has 200 active processes and you change the total process limit on the WPAR to 170, then the system will not terminate the extra 30 processes. New process creation within the WPAR is not allowed until the process count falls below 170. You can enable resource controls for a WPAR when it is created. You can also change the controls on an existing WPAR using SMIT or using the **chwpar** command with the **-R active = yes** option.

Related tasks

"Configuring resource controls for system WPARs" on page 19
You can configure the resource controls to limit the physical resources a system WPAR has access to using the **-R** flag for the **mkwpar** command and **chwpar** command.

Processor use and memory use controls

Processor use controls and memory use controls allow you to allocate processor and memory resources for the global environment.

You can use share-based allocation or percentage-based allocation for processor and memory resources.

Note: Both share-based controls and percentage-based controls can be specified. In the event of conflict, the percentage-based controls take precedence.

Share-based allocation

The percentage of CPU or memory to allocate to the WPAR is determined by dividing the number of shares by the total number of shares allocated to all active WPARs. The number of shares represents how much of a particular resource a WPAR receives relative to the other WPARs.

For example, if there are three active WPARs (A, B, and C) with shares for a particular resource of 15, 10, and 5, allocation targets would be the following:

WPAR A, 15/30 or 50%

WPAR B, 10/30 or 33%

WPAR C, 5/30 or 17%

Allocation targets adjust with the number of active workload partitions. If partition A is inactive, then the allocation targets would be the following:

WPAR B, 10/15 or 66%

WPAR C, 5/15 or 33%

Share-based allocation is specified by using the **shares_CPU** option with the **mkwpar** command or the **chwpar** command.

Percentage-based allocation

The percentage of CPU or memory to allocate to the WPAR is determined by the following user-specified values:

min%

The minimum amount of a resource that should be made available to the WPAR. If the actual consumption is below this value, the WPAR will be given highest priority access to the resource. The possible values are 0 to 100, with a default value of 0.

soft%
The maximum amount of a resource that a WPAR can use when there is contention for that resource. If the WPAR's consumption exceeds this value, the WPAR will be given the lowest priority access to the resource. If there is no contention for the resource, the WPAR is allowed to consume as many resources as it requires. The possible values are .01 to 100, with a default value of 100.

hard%
The maximum amount of a resource that a WPAR can consume, even when there is no contention. If the class reaches this limit, it will not be allowed to consume any more of the resource until its consumption percentage falls below the limit. The possible values are .01 to 100, with a default value of 100.

Note: Using hard maximum limits can have a significant impact on system or application performance if not used appropriately. Because imposing hard limits can result in unused system resources, in most cases, soft maximum limits are more appropriate.

Devices in WPARs

Different types of devices are supported by the AIX operating system, although the initial support of devices in the WPAR is limited to fiber-attached storage devices, fiber channel adaptors, and virtual Small Computer System Interface (SCSI) disks.

Inactive WPAR

With an inactive WPAR, a storage device can be allocated and de-allocated to any number of WPARs. The first WPAR that starts takes ownership of the device, which means that device will be unconfigured in the global environment and reconfigured in the WPAR. You can not make any configuration changes on the device in the global environment when the device is in use by the WPAR. There are no restrictions on removing a device from an inactive WPAR.

Active WPAR

There are two ways that a device can be allocated to an active WPAR.

- If a device is not in use by another WPAR, the **cfgmgr** command allocates the device to the WPAR and makes the device available for use in the WPAR.
- If a device is in use by another WPAR, it is added to the WPAR file configuration. This device is not made accessible to the WPAR because it is already in use by another WPAR.

When an active WPAR has control of a device, the device is in the defined state in the global environment. No configuration operations are allowed on the device as long as it is in the global environment. Commands such as **mkdev, chdev, rmdev,** and **cfgmgr** will not work on the device. In order for the global environment to take control of the device, it has to be deallocated from the WPAR that has control over it.

Related concepts

"Devices" on page 2
To function properly, some applications require the use of system devices.

"Rootvg WPARs" on page 11
A system WPAR which is configured with its own root volume group on one or more dedicated storage devices is called a rootvg WPAR. Configuring a rootvg WPAR gives the WPAR administrator complete control over managing the storage devices exported to the WPAR, the volume groups on those devices, and the logical volumes and file systems within those volume groups. A system WPAR which is not a rootvg WPAR does not have its own root volume group, but has file systems created in logical volumes created out of the root volume group of the global system.

Deploying a device

A device can be allocated to a WPAR when the WPAR is created or added to the WPAR in a later operation.

In order for a device to be allocated to a WPAR, the device must be in the available state or the defined state in the global environment. To deploy a device it must be in the available state or the defined state.

Related information

lsdev command

Allocating a device

The allocation process consists of providing a storage device that can be used by the WPAR.

A device can be allocated to more than one WPAR, but can be used only by one WPAR at a time. To allocate a device when creating the WPAR, run the following command:

```
mkwpar -D devname=<device name> -n <wpar name>
```

For a rootvg WPAR, the device to hold the rootvg must be specified, as in the following example:

```
mkwpar -D devname=<device name> rootvg=yes -n <wpar name>
```

The -D parameter can be repeated to specify multiple storage devices.

To allocate a device to an existing WPAR, run the following command:

```
chwpar -D devname=<device name> <wpar name>
```

Additional disks can be allocated to a WPARs root volume group with the following command:

```
chwpar -D devname=<device name> rootvg=yes <wpar name>
```

To remove a device from an active or non-active WPAR, run the following command from the global environment:

```
chwpar -K -D devname=<device name> <wpar name>
```

When the command for an inactive WPAR runs successfully, the device is removed from the WPAR configuration. However, for an active WPAR, the command attempts to unconfigure the device from the WPAR. If the device is in use, the unconfiguration operation fails and the command to remove the device from the WPAR fails. When the command for an active WPAR runs successfully, the device in the WPAR changes from the available state to the defined state.

Related information

chwpar command

lsdev command

Configuring a device in a WPAR

Every device that is configured in the WPAR has an ODM entry in the WPAR.

The storage device has a parent device that is a virtualized device. You can not make any configuration changes on the parent device in the WPAR, or modify any management paths to the device.

The following commands are used to configure and manage the global environment, and are also used in the same manner to configure and manage devices in the WPAR:

- **mkdev**
- **chdev**
- **rmdev**
- **lsdev**
- **cfgmgr**
- **lsattr**
- **lspath**

Related information

mkdev command

chdev command

rmdev command

lsdev command

cfgmgr command

lsattr command

lspath command

Managing file systems for a device

When the device is configured in a rootvg WPAR, commands that are used to create and manage volume groups, logical volumes, and file systems operate in the same manner as in the global environment.

To create and modify volume groups, use the following commands:

- **mkvg**
- **importvg**
- **importvg**
- **extendvg**
- **importvg**

To create and modify logical volumes, use the following commands:

- **mklv**
- **chlv**

To create and modify file systems, use the following commands:

- **mkfs**
- **chfs**

For more information about the commands, see Commands.

System WPARs

System WPARs are autonomous virtual system environments with their own private file systems, users and groups, login, network space and administrative domain.

Most traditional system services are virtualized at the WPAR level, and they can be independently used and managed within each WPAR. While the system WPAR environment is largely partitioned and isolated, read-only file systems might be shared between WPARs to facilitate the sharing of application data and text. Versioned WPARs can only be non-shared system WPARs.

Shared and non-shared system WPARs

By default, a system WPAR shares the `/usr` file system and the `/opt` file systems from the global environment using read-only **namefs** mounts. You can configure WPARs to have non-shared, writable `/usr` file system and `/opt` file system.

To configure a non-shared system WPAR, run the **mkwpar** command with the **-l** flag.

You can also configure a non-shared system WPAR by specifying writable file systems of one of the following types for the `/usr` file system and the `/opt` file system:

- directory
- jfs
- jfs2
- nfs

If you create a non-shared system WPAR, all files from the `/usr` file system and the `/opt` file system in the global environment are copied to the WPAR. The administrator must allocate enough space in the WPAR file systems for the files.

System software in non-shared system WPARs must be kept at the same system level as the global environment in order to avoid unexpected results.

Related concepts

"Recovering incompatible detached Workload Partitions" on page 27
It is possible that the system software in a detached workload partition (WPAR) may become incompatible with the levels of system software in the global environment. This occurs if software installation and maintenance tasks are performed independently in the global environment and the WPAR, or if a WPAR backup image from an incompatible system level was installed.

Related information

Installing and managing software with detached WPARs

File systems for system WPARs

System WPARs have their own file systems similar to stand-alone AIX.

System WPARs can be created with local file system spaces, which are constructed from isolated sections of the file system space for the global environment or with a WPAR owned root volume group.

When the system WPAR has isolated file system spaces, each file system is owned and managed by the global environment. For a WPAR owned root volume group, dedicated storage devices must be allocated to the WPAR and each file system is owned and managed by the WPAR.

Global isolated file system spaces

The default location for the file system spaces are in the `/wpars` directory of the global environment. The initial process for each WPAR is moved to the correct path in the global file system using the **chroot**

command. All processes run within the WPAR appear in the base directory for the WPAR. For example, users in a WPAR would see the /wpars/part1/usr directory as the /usr directory.

The file system configuration for a WPAR is specified when the WPAR is created. You can either use the system defaults or customize each file system. Some of the file systems in a system WPAR are local to the partition while others can be shared with the global environment.

The following JFS2 file systems are created with inline logs and populated similar to a stand-alone AIX system with the following sizes:

- / (64 MB)
- /tmp (96 MB)
- /var (128 MB)
- /home (32 MB)

Note: The initial sizes of these file systems could change depending upon the system requirements and storage characteristics.

The following JFS2 file systems are shared from the global environment using **namefs** mounts with the followed permissions:

- /usr (read-only permissions)
- /opt (read-only permissions)
- /proc (read-write permissions)

You can specify the use of a flat file system structure for part or all of a WPAR namespace by specifying that one or more directories should be local to a parent directory. This structure means that no distinct file system is created for the parent directory. The sizes of the file systems or directories to be populated in the WPAR must be large enough to hold the files for that partition. This structure simplifies the number of file systems to manage for a partition, but it loses the granularity of control over user files populating the file system. The flat file system structure might be a viable option for servers running in the WPAR that do not offer system login privileges to users.

File systems in a rootvg WPAR

When a system WPAR is created with its own root volume group by using the **mkwpar** command with the **–D** flag and specifying the **disk name devname=*hdisk name*** and the **rootvg=yes** option, the root file systems are created in a separate volume group that is owned and managed by the WPAR. For example, two disks can be allocated for the root volume group by using these options **-D devname=hdisk5 rootvg=yes -D devname=hdisk6 rootvg=yes**. The following JFS2 file systems are created within the WPAR-owned root volume group with inline logs, and populated similar to a stand-alone AIX system:

- /
- /admin
- /home
- /tmp
- /var

Note: The initial sizes of these file systems can change depending on the system requirements and storage characteristics.

If a non-shared system WPAR is created that owns the root volume group, the /usr file system and /opt file system are created and populated within the WPAR owned root volume group. Versioned WPARs always have non-shared /usr and /opt file systems. Otherwise, the /usr file system and /opt file system are shared from the global environment by using namefs mounts.

Note: The logical volume names used within a rootvg WPAR are the same as those typically used on an AIX system. For example, `/dev/hd4` would be the logical volume name for the root `/` file system and `/dev/hd11admin` for the `/admin` file system.

The WPAR administrator can change the file system characteristics of any file system that resides within the WPAR-owned root volume group.

Related tasks

"Creating a writable directory under a shared directory" on page 15
You can create a writable directory beneath a shared directory using a symbolic link from the global environment.

Rootvg WPARs

A system WPAR which is configured with its own root volume group on one or more dedicated storage devices is called a rootvg WPAR. Configuring a rootvg WPAR gives the WPAR administrator complete control over managing the storage devices exported to the WPAR, the volume groups on those devices, and the logical volumes and file systems within those volume groups. A system WPAR which is not a rootvg WPAR does not have its own root volume group, but has file systems created in logical volumes created out of the root volume group of the global system.

For a rootvg WPAR, storage devices must be exported (or allocated) to the WPAR when it is created. After it has been created, the **chwpar** command can be used to allocate additional disks to the WPARs root volume group or, if it contains multiple disks, to deallocate a disk from the WPARs root volume group. It is not possible to change a WPAR without its own root volume group into a rootvg WPAR after it has been created.

Rootvg WPARs can be configured to support live application mobility when used in combination with *IBM® PowerVM™ Workload Partitions Manager™ for AIX*.

"File systems for system WPARs" on page 9

A configuration with a WPAR owned root volume group (a RootVG WPAR) helps to isolate the file systems and volume groups of a WPAR from the global system.

Rootvg WPAR mobility considerations

A WPAR whose file systems are all NFS mounted or all SAN based is eligible for Live Application Mobility, wherein a workload running in a WPAR on one LPAR might be moved to another compatible LPAR and execution resumed at the same point. This relocation of a WPAR involves moving its executable code to the target LPAR, while keeping the application data on the same storage devices. Thus, the storage devices containing the file systems must be visible and accessible from both LPARs.

Note: IBM PowerVM Workload Partitions Manager for AIX (WPAR Manager) is required for WPAR mobility.

A typical configuration might include two SAN based disks containing the rootvg of the WPAR, with a third SAN based disk exported to the WPAR and containing a separate volume group with application data. This gives the WPAR administrator complete control over creating new file systems or resizing the existing file systems within those volume groups. If the intent is to be able to relocate the WPAR,the WPAR Manager can be used to create the WPAR, as well as to move it between LPARs.

Related concepts

"Devices in WPARs" on page 6
Different types of devices are supported by the AIX operating system, although the initial support of devices in the WPAR is limited to fiber-attached storage devices, fiber channel adaptors, and virtual Small Computer System Interface (SCSI) disks.

Related tasks

"Creating a writable directory under a shared directory" on page 15
You can create a writable directory beneath a shared directory using a symbolic link from the global environment.

Application workload partitions

Application workload partitions (WPARs) provide an environment for isolation of applications and their resources to enable checkpoint, restart, and relocation at the application level.

Application WPARs have less overhead on system resources than system WPARs. Application WPARs do not require their own instance of system services.

File systems for application WPARs

Application WPARs share the global environment's file system namespace. When an application WPAR is created, it has access to all mounts available to the global environment's file system.

If additional dependencies are required, you can customize the WPAR during creation using the **wparexec** command with the **-M** option. The supported file system types for application WPARs include the same types as for system WPARs, with the exception that no file systems can be created by the **wparexec** command. If a separate local file system is required, you must create it prior to creating the application WPAR.

Related tasks

"Configuring directories and file systems for application WPARs" on page 22
Application WPARs share file systems with the global environment. You can use the **-M** flag for the **wparexec** command to configure directories and file systems.

Configuring system WPARs

You can create and configure system WPARs using the **mkwpar** command and the **chwpar** command.

When you create a system WPAR, a configuration profile is stored in the WPAR database. You can export this profile to create a specification file that contains the exact same configuration information for that WPAR. All WPARs must be created by an authorized administrator in the global environment.

Note: These topics provide specific examples of how to run WPAR-related commands. For complete documentation of all options for a specific command, see the related information for that task.

Related information

Installing and managing software with detached WPARs

Naming the system WPAR

You must provide a name for the system WPAR. You can provide a name using the **mkwpar** command with the **-n** flag.

You can specify the name for the system WPAR using the following command:

```
mkwpar -n wpar_name
```

You can also change the name of a system WPAR using the **chwpar** command. You can only change the name of a system WPAR when it is stopped and in the defined state. To change the name of a system WPAR, run the following command:

```
chwpar -n new_name old_name
```

Creating a system WPAR

You can create a new system WPAR with the **mkwpar** command.

Each WPAR has an isolated network environment with unique IP addresses and a unique hostname. You can access WPARs through standard networking programs, such as telnet, ftp, and rlogin (depending on the services running in the WPAR). Before you create a WPAR, you should log in as the root user and complete one of the following prerequisites:

- Choose a name for the WPAR that maps to an IP address for your network.
- Add an entry for the new system WPAR to the `/etc/hosts` file on the server. The entry should include the host name for the WPAR and the name of the WPAR as follows:

  ```
  9.3.18.10 WPARname.austin.ibm.com WPARname
  ```

To create a new system WPAR, complete the following steps.

1. Verify that the network recognizes your workload partition address by entering the following command:

   ```
   #host WPARname
   ```

   The return should look similar to the following:

   ```
   WPARname.austin.ibm.com is 9.3.18.10,  Aliases:  WPARname
   ```

2. Configure the WPAR by running the following command:

   ```
   mkwpar -n WPARname
   ```

The initial output of the **mkwpar** command should look similar to the following:

```
mkwpar -n WPARname mkwpar:
Creating filesystems...
     /
     /home
     /opt
     /proc
     /tmp
     /usr
     /var
populate: Mounting all workload partition file systems
x ./usr
x ./lib
x ./audit
x ./dev
x ./etc
x ./etc/check_config.files
x ./etc/consdef
x ./etc/cronlog.conf
x ./etc/csh.cshrc
x ./etc/csh.login
x ./etc/dlpi.conf
x ./etc/dumpdates
x ./etc/environment
x ./etc/ewlm
x ./etc/ewlm/limits
x ./etc/filesystems
x ./etc/group
```

```
x ./etc/inittab
x ./etc/magic
x ./etc/motd
...
```

Each system WPAR has an isolated section of the system's file space configured for the root directory, the /home directory, the /usr directory and other file systems. Creation and configuration of this space is reflected in the above output from the **mkwpar** command. The return from the **mkwpar** command continues with output similar to the following:

```
x ./home
x ./home/guest
x ./home/lost+found
+-----------------------------------------------------------------------------+
Pre-installation Verification...
+-----------------------------------------------------------------------------+
Verifying selections...done
Verifying requisites...done
Results...

SUCCESSES
---------
Filesets listed in this section passed pre-installation verification
and will be installed.
...
```

Each system workload partition has its own /dev directory. Creation and configuration of this space is reflected in the `populate: Exporting workload partition devices` output from the **mkwpar** command. Not all of the devices on the system can be shared among the WPARs so the WPAR's /dev directory is a sparse version of the /dev directory on the global environment. The **mkwpar** command then continues with the installation of several AIX base system file sets into the WPAR. At the end of the installation phase, you should see output similar to the following:

```
Finished processing all filesets. (Total time:  1 mins 4 secs).

Please wait...

     /usr/sbin/rsct/install/bin/ctposti
0513-071 The ctcas Subsystem has been added.
0513-071 The ctrmc Subsystem has been added.
done
+-----------------------------------------------------------------------------+
Summaries:
+-----------------------------------------------------------------------------+
Installation Summary
--------------------
Name                        Level           Part        Event       Result
-------------------------------------------------------------------------------
Tivoli_Management_Agent.cli 3.7.1.0         ROOT        APPLY       SUCCESS
bos.acct                    5.3.0.9500      ROOT        APPLY       SUCCESS
bos.diag.util               5.3.0.40        ROOT        APPLY       SUCCESS
bos.mh                      5.3.0.40        ROOT        APPLY       SUCCESS
bos.net.ncs                 5.3.0.0         ROOT        APPLY       SUCCESS
bos.net.nfs.client          5.3.0.9500      ROOT        APPLY       SUCCESS
bos.net.nis.client          5.3.0.40        ROOT        APPLY       SUCCESS
bos.net.snapp               5.3.0.0         ROOT        APPLY       SUCCESS
bos.net.tcp.client          5.3.0.9500      ROOT        APPLY       SUCCESS
bos.net.tcp.server          5.3.0.9500      ROOT        APPLY       SUCCESS
bos.net.uucp                5.3.0.40        ROOT        APPLY       SUCCESS
...
bos.net.ipsec.rte           5.3.0.9500      ROOT        APPLY       SUCCESS
```

```
bos.perf.tune               5.3.0.9500      ROOT        APPLY       SUCCESS
devices.chrp.base.diag      5.3.0.40        ROOT        APPLY       SUCCESS
bos.net.ipsec.keymgt        5.3.0.9500      ROOT        APPLY       SUCCESS
ifor_ls.base.cli            5.3.0.30        ROOT        APPLY       SUCCESS
lum.base.cli                5.1.0.0         ROOT        APPLY       SUCCESS
bos.suma                    5.3.0.40        ROOT        APPLY       SUCCESS
mkwpar: Workload partition WPARname created successfully.
To start the workload partition, execute the following as root: startwpar [-v] 'WPARname'
```

The configuration of the system WPAR is now complete.

Configuring directories and file systems for system WPARs

You can override the default location of the file systems for a system WPAR using the **mkwpar** command with the **-d** option.

By default, the file systems for a new system WPAR are located in the /wpars/*wpar_name* directory.

You can override the default location using the following command:

```
mkwpar -n wpar_name -d /newfs/wpar_name
```

For safety and security, the specified base directory must meet the following criteria:

- The directory must be empty.
- The directory must not be a registered file system in the /etc/filesystems directory.
- The directory must have permissions of 755 (rwxr-xr-x).
- The parent directory of the base directory (*/newfs*, in the example) must have permissions of 700 (rwx------).

You can also change the base directory of an existing system WPAR, using the following command:

```
chwpar -d /newfs/newbase wpar_name
```

The same criteria apply for changing the base directory with the **chwpar** command. The base directory can only be changed on a stopped system WPAR.

File system customization for system WPARs

You can customize the file systems for a system WPAR using the **mkwpar** command with the **-M** option. A WPAR may use namefs mounts from any type of file system which supports POSIX file system semantics when mounted with a namefs mount. If the namefs mount is used for the root file system of the WPAR, than the file system being used must support the creation and use of block and character devices within the WPAR.

The following file system types are supported using the **vfs** attribute of the **-M** option:

- JFS
- JFS2
- NFS
- Namefs

You can also specify that a directory should be created instead of a file system by specifying vfs=directory. Specify this attribute in situations where you do not want to maintain a large number of separate file systems.

Creating a writable directory under a shared directory

You can create a writable directory beneath a shared directory using a symbolic link from the global environment.

If you are customizing software within a system WPAR, it might be useful or necessary to have a writable directory beneath a directory shared from the global environment. For example, it is common for open source software to install into a `/usr/local` directory hierarchy by default. In order to accommodate an unshared, writable `/usr/local` directory hierarchy, the global environment administrator must create a writable `/usr/local` directory. Create a file system called `/wpars/wparname/usr/local` with the `type=wparname` option.

Related concepts

"File systems for system WPARs" on page 9
System WPARs have their own file systems similar to stand-alone AIX.

"Rootvg WPARs" on page 11
A system WPAR which is configured with its own root volume group on one or more dedicated storage devices is called a rootvg WPAR. Configuring a rootvg WPAR gives the WPAR administrator complete control over managing the storage devices exported to the WPAR, the volume groups on those devices, and the logical volumes and file systems within those volume groups. A system WPAR which is not a rootvg WPAR does not have its own root volume group, but has file systems created in logical volumes created out of the root volume group of the global system.

Rootvg WPARs

A system WPAR which is configured with its own root volume group on one or more dedicated storage devices is called a rootvg WPAR. Configuring a rootvg WPAR gives the WPAR administrator complete control over managing the storage devices exported to the WPAR, the volume groups on those devices, and the logical volumes and file systems within those volume groups. A system WPAR which is not a rootvg WPAR does not have its own root volume group, but has file systems created in logical volumes created out of the root volume group of the global system.

For a rootvg WPAR, storage devices must be exported (or allocated) to the WPAR when it is created. After it has been created, the **chwpar** command can be used to allocate additional disks to the WPARs root volume group or, if it contains multiple disks, to deallocate a disk from the WPARs root volume group. It is not possible to change a WPAR without its own root volume group into a rootvg WPAR after it has been created.

Rootvg WPARs can be configured to support live application mobility when used in combination with *IBM PowerVM Workload Partitions Manager for AIX*.

"File systems for system WPARs" on page 9

A configuration with a WPAR owned root volume group (a RootVG WPAR) helps to isolate the file systems and volume groups of a WPAR from the global system.

Rootvg WPAR mobility considerations

A WPAR whose file systems are all NFS mounted or all SAN based is eligible for Live Application Mobility, wherein a workload running in a WPAR on one LPAR might be moved to another compatible LPAR and execution resumed at the same point. This relocation of a WPAR involves moving its executable code to the target LPAR, while keeping the application data on the same storage devices. Thus, the storage devices containing the file systems must be visible and accessible from both LPARs.

Note: IBM PowerVM Workload Partitions Manager for AIX (WPAR Manager) is required for WPAR mobility.

A typical configuration might include two SAN based disks containing the rootvg of the WPAR, with a third SAN based disk exported to the WPAR and containing a separate volume group with application data. This gives the WPAR administrator complete control over creating new file systems or resizing the existing file systems within those volume groups. If the intent is to be able to relocate the WPAR,the WPAR Manager can be used to create the WPAR, as well as to move it between LPARs.

Related concepts

"Devices in WPARs" on page 6
Different types of devices are supported by the AIX operating system, although the initial support of devices in the WPAR is limited to fiber-attached storage devices, fiber channel adaptors, and virtual Small Computer System Interface (SCSI) disks.

Related tasks

"Creating a writable directory under a shared directory" on page 15
You can create a writable directory beneath a shared directory using a symbolic link from the global environment.

Configuring networks for system WPARs

You can configure the network for a system WPAR using the **-h** flag or the **-N** flag for the **mkwpar** command or the **chwpar** command.

If you do not specify any network information when you create a system WPAR, and the name of the WPAR resolves to an IP address on the same network as any active global interface, the **mkwpar** command automatically configures the network for the WPAR. If the WPAR does not resolve, you can specify zero or more network configurations using the **-N** flag for the **mkwpar** command or the **chwpar** command. All network changes can be performed on active or inactive WPARs. The changes take effect immediately.

Each network requires its own instance of the **-N** flag. The **-N** flag specifies network configuration attributes, and is used to separate the `attribute=value` pairs by blank spaces. You can specify more than one **-N** flag to configure multiple IP addresses. For example:

```
mkwpar -n wpar_name -N interface=en0 address=224.128.9.3 \
netmask=255.255.255.0 broadcast=224.128.9.255 -N interface=en1 \
address=192.168.0.3 netmask=255.255.255.0 broadcast=192.168.0.255
```

To configure a system WPAR with a network address of 224.128.9.3 using the en0 interface for the global environment, run the following command:

```
mkwpar -n wpar_name -N interface=en0 address=224.128.9.3 \
netmask=255.255.255.0 broadcast=224.128.9.255
```

To configure a system WPAR with an IPv6 network address of fe80::200:254 using the en3 interface from the global environment, run the following command:

```
mkwpar -n wpar_name -N interface=en3 address6=fe80::200:254 prefixlen=64
```

You can also use the **-N** flag with the **chwpar** command to add additional networks on a previously defined system WPAR. To add a network, run the following command:

```
chwpar -N address=224.128.9.4 wpar_name
```

If you want to change the network settings for a system WPAR, use the **address** attribute to identify the network you want to change. For example, to change the netmask and broadcast address of the network at 224.128.9.3, run the following command:

```
chwpar -N address=224.128.9.3 netmask=255.255.255.128 \
broadcast=224.128.9.127 wpar_name
```

Related concepts

"Networking" on page 3
A WPAR can have one or more network addresses assigned to support network login and network services.

Changing the host name for a system WPAR

By default, the name for a system WPAR is used as its host name. You can use the **-h** flag with the **mkwpar** command or the **chwpar** command to change the host name for a system WPAR.

To override the default host name when you create a system WPAR, run the following **mkwpar** command:

```
mkwpar -n wpar_name -h wpar_hostname
```

To change the host name for an existing system WPAR, run the following **chwpar** command:

```
chwpar -h new_hostname wpar_name
```

Removing a network from a system WPAR

You can remove a network from a system WPAR using the **chwpar** command with the **-K** flag.

To remove a network from the system WPAR, run the following **chwpar** command, using the address of the network to identify it:

```
chwpar -K -N address=124.128.9.3 wpar_name
```

Note: There is no direct way to change the address of a system WPAR network; you must remove the old network with the **chwpar -K** command and add the network with the new address.

Configuring domain resolution for system WPARs

You can configure the domain resolution for system WPARs using the **-r** flag for the **mkwpar** command.

Files such as the `/etc/resolv.conf` file do not exist in system WPARs by default.

To copy the global environment's domain resolution configuration into the system WPARs, run the following command:

```
mkwpar -n wpar_name -r
```

Running this command copies the following files into the system WPARs, if they exist in the global environment:

- `/etc/resolv.conf`
- `/etc/hosts`
- `/etc/netsvc.conf`
- `/etc/irs.conf`
- `/etc/networks`

If the NSORDER environmental variable is set in the environment where you run the **mkwpar** command, the variable is added to the `/etc/environment` file for the new system WPAR.

The **-r** flag is not supported by the **chwpar** command. Any changes to the domain resolution configuration of an existing WPAR must be made by manually editing the relevant files.

Configuring WPAR-specific routing

You can configure a WPAR to use its own routing table using the **-i** flag and the **-I** flag for the **mkwpar** command, the **wparexec** command, or the **chwpar** command.

By default, system and application workload partitions with active network connections share the global system's routing table. To enable WPAR-specific routing for a WPAR when you are creating the WPAR, add the **-i** flag to the command line of the **mkwpar** command or the **wparexec** command. For system WPARs:

```
mkwpar -n wpar_name -N network_attributes -i ...
```

For application WPARs:

```
wparexec -N network_attributes -i ... -- /path/to/application arg1 arg2 ... argN
```

Using these commands will automatically create loopback, broadcast, and subnet routes appropriate to each configured address. If you do not specify any explicit routing table entries, the WPAR will only be able to communicate within its own subnets. You can configure explicit routing table entries with **-I** flag when you create the WPAR. You can configure zero or more explicit routing table entries. Each entry requires its own instance of the **-I** flag. Destination and gateway addresses can be specified by symbolic name or IP address.

For example, to configure a default route through a gateway with symbolic name gateway.customer.com and a host route to myserver.customer.com through gateway 192.168.1.1:

```
mkwpar -n wpar_name -N network_attributes -i -I rtdest=default rtgateway=gateway.customer.com \
-I rtdest=myserver.customer.com rttype=host rtgateway=192.168.1.1 ...
```

The **netstat -r** command can be used with the **-@** flag to view the WPAR-specific routing table for a WPAR at any time. If WPAR-specific routing is disabled for the queried WPAR, the **netstat -r** command will display the global routes. The output format is identical to that of the **netstat -r** command without the **-@** flag. For example:

```
netstat -r -@ wpar_name
```

You can change the WPAR-specific routing characteristics for both system WPARs and application WPARs using the **chwpar** command. The changes can be performed on active WPARs or inactive WPARs. Changes take effect immediately, and persist across system WPAR reboots. To disable WPAR-specific routing, causing the affected WPAR to begin using the global routing tables, use the following command:

```
chwpar -K -i wpar_name
```

To enable WPAR-specific routing and add a route for destinations in subnet 224.128.9.0/24 through gateway 224.128.9.1 on interface en4, use the following command::

```
chwpar -i -I rtdest=224.128.9.0 rtnetmask=255.255.255.0 rtgateway=224.128.9.1 rtinterface=en4 wpar_name
```

To delete an existing WPAR-specific route entry, you must provide enough information to identify the entry being deleted. In most cases, it is effective to use the same attributes provided when the route was configured. For example, use the following command to remove the route configured in the previous example:

```
chwpar -K -I rtdest=224.128.9.0 rtnetmask=255.255.255.0 rtgateway=224.128.9.1 rtinterface=en4 wpar_name
```

Related concepts

"Configuring application WPARs" on page 21
You can create and configure application WPARs using the **wparexec** command and the **chwpar** command.

Configuring resource controls for system WPARs

You can configure the resource controls to limit the physical resources a system WPAR has access to using the **-R** flag for the **mkwpar** command and **chwpar** command.

To initialize resource control settings, run the following **mkwpar** command:

```
mkwpar -n wpar_name -R active=yes CPU=10%-20%,50% totalProcesses=1024
```

In this example, the WPAR is entitled to the following system resources:

- A minimum of 10% of the global environment's processors upon request
- A maximum of 20% of the global environment's processors when there is contention
- A maximum of 50% of the global environment's processors when there is no contention
- A maximum of 1024 processes at a time

The **active** attribute can be set to `yes` or `no`. When the **active** attribute is set to `no`, resource controls are disabled, but the settings are maintained in the configuration database.

To change resource control settings dynamically for an existing active or inactive application WPAR run the following **chwpar** command:

```
chwpar -R totalThreads=2048 shares_memory=100 wpar_name
```

Note: You can also use the **-K** flag for the **chwpar** command to remove individual attributes from the profile and restore those controls to their default, as follows:

```
chwpar -K -R totalProcesses shares_CPU wpar_name
```

Related concepts

"Resource controls" on page 5
WPARs support up to 8192 resource-controlled workload partitions. The number of non-resource-controlled WPARs that can be created is constrained only by the availability of global environment memory and disk space resources. However, a maximum of 8192 can be active at any time.

Using specification files for system WPARs

You can create a WPAR with all of the options from a specification file using the **-f** flag for the **mkwpar** command.

To use a specification file to create a system WPAR, run the **mkwpar** command as follows:

```
mkwpar -f /tmp/specfile1
```

To create a specification file as part of the WPAR creation process, run the following **mkwpar** command with the **-o** flag:

```
mkwpar -n wpar_name -o /tmp/specfile2
```

Note: If the name of the system WPAR is provided in the specification file, the **-n** flag is not required. The specification file reflects the settings being used to create the WPAR.

To generate a specification file without creating the WPAR, run the following **mkwpar** command with the **-w** flag and the **-o** flag:

```
mkwpar -o /tmp/specfile3 -w
```

For a comprehensive description of the format and permitted contents of a specification file, see the `/usr/samples/wpars/sample.spec` file.

Using an `image.data` file for system WPARs

You can use an `image.data` file to specify additional logical volume options and file system options when you create a system WPAR using the **mkwpar** command with the **-L image_data=** flag.

The following restrictions apply to using `image.data` files with system WPARs:

- WPARs use only the `lv_data` stanza type and the `fs_data` stanza type in an `image.data` file. All other stanza types are ignored.
- If the logical volume device name matches an existing device name on the system, a new name is generated, and a warning is issued.
- The file system paths specified with the **FS_NAME** attribute should correspond to their appearance in the WPAR (for example, the root file system is `/` and the home file system is `/home`).
- The base directory for the global environment should not be included in `image.data` paths.
- All file systems must have associated LVs in the `image.data` file.
- All logical volumes must have associated file systems in the `image.data` file.

To create a system WPAR using the logical volume options and file system options in an `image.data` file, run the following command:

```
mkwpar -L image_data=image.data file -n wpar_name
```

Related information

image.data file

Configuring application WPARs

You can create and configure application WPARs using the **wparexec** command and the **chwpar** command.

When you create an application WPAR, a configuration profile is stored in the WPAR database. You can export this profile to create a specification file that contains the exact same configuration information for that WPAR. All WPARs must be created by an authorized administrator in the global environment.

Note: These topics provide specific examples of how to run WPAR-related commands. For complete documentation of all options for a specific command, see the related information for that task.

Related concepts

"Configuring WPAR-specific routing" on page 18
You can configure a WPAR to use its own routing table using the **-i** flag and the **-I** flag for the **mkwpar** command, the **wparexec** command, or the **chwpar** command.

Creating an application WPAR

You can create an application WPAR using the **wparexec** command.

You must supply the path to the application or command that you want to create an application WPAR for, and you must supply any command line arguments when you run the **wparexec** command. The application can either come from a specification file, or be specified on the command line. Unlike system WPARs, it is not necessary to assign an explicit name to an application WPAR. Although both WPAR types require a name, the names for application WPARs are generated based on the name of the application running in the WPAR.

Complete the following steps to create an application WPAR:

1. Log in as the root user to the system where you want to create and configure the workload partition. This login places you into the global environment.
2. To create and configure the workload partition, run the following command:

   ```
   wparexec -n wparname -- /usr/bin/ps -ef > /ps.out
   ```

   The output should look similar to the following:

   ```
   wparexec: Verifying filesystems...
   wparexec: Workload partition wparname created successfully.
   startwpar: COMMAND START, ARGS: wparname
   startwpar: Starting workload partition 'wparname'
   startwpar: Mounting all workload partition file systems
   startwpar: Loading workload partition
   startwpar: Shutting down all workload partition processes
   rmwpar: Removing workload partition firstapp
   rmwpar: Return Status = SUCCESS
   startwpar: Return Status = SUCCESS
   ```

You have now successfully created an application WPAR.

Application WPARs start as soon as the **wparexec** command is issued, and stop as soon as the application completes its operation. When the operation is complete, the configuration for the application WPAR is destroyed.

Configuring directories and file systems for application WPARs

Application WPARs share file systems with the global environment. You can use the **-M** flag for the **wparexec** command to configure directories and file systems.

Unlike system WPARs, application WPARs do not have a base directory. You cannot override the default settings for the local file system dependencies, but you can use the **-M** flag for the **wparexec** command to specify additional file system dependencies, such as a remote NFS mount. The **directory** attribute represents the mount point and this attribute is required for all instances created with the **-M** flag. The directory mount point will appear both in the WPAR and in the global environment.

Application WPARs do not create new file systems. Therefore, the local JFS and JFS2 file system types cannot be specified. A local file system dependency can be specified, but it must already exist in the `/etc/filesystems` directory.

To mount the remote `/export/shared` directory over the `/shared` directory in the global environment, run the following **wparexec** command with the **-M** flag, using the appropriate values for your environment:

```
wparexec -M directory=/shared vfs=nfs host=homeserver.customer.com dev=/export/shared \
-- /path/to/application arg1 arg2 ... argN
```

To specify a local file system dependency, specify only the directory attribute for that mount stanza, as follows, using the appropriate values for your environment:

```
wparexec -M directory=/mylocalshare -- /path/to/application arg1 arg2 ... argN
```

Related concepts

"File systems for application WPARs" on page 12
Application WPARs share the global environment's file system namespace. When an application WPAR is created, it has access to all mounts available to the global environment's file system.

Configuring networks for application WPARs

You can configure the network for an application WPAR using the **-h** flag and the **-N** flag for the **wparexec** command or the **chwpar** command.

By default, the name of an application WPAR is used as its host name.

To override the default hostname for an application WPAR when you are creating it, run the following **wparexec** command with the **-h** flag:

```
wparexec -h wpar_hostname -- /path/to/application arg1 arg2 ... argN
```

You can also change the host name for an application WPAR at any time using the **-h** flag with the following **chwpar** command:

```
chwpar -h new_hostname wpar_name
```

If you do not specify any network information when you create an application WPAR, and the name of the WPAR resolves to an IP address on the same network as any active global interface, the **wparexec** command automatically configures the network for the WPAR. If the WPAR name does not resolve, you can specify zero or more network configurations using the **-N** flag for the **wparexec** command or the **chwpar** command. All network changes can be performed on active or inactive WPARs. The changes take effect immediately.

Each network requires its own instance of the **-N** flag. The **-N** flag specifies network configuration attributes, and is used to separate the `attribute=value` pairs by blank spaces. You can specify more than one **-N** flag to configure multiple IP addresses. For example:

```
wparexec -N interface=en0 address=224.128.9.3 netmask=255.255.255.0 broadcast=224.128.9.255 \
-N interface=en1 address=192.168.0.3 netmask=255.255.255.0 broadcast=192.168.0.255 \
-- /path/to/application arg1 arg2 ... argN
```

To configure an application WPAR with an IPv6 address of fe80::200:214 using the en3 interface from the global environment, run the following command:

```
wparexec -N interface=en3 address6=fe80::200:214 prefixlen=64 \
-- /path/to/application arg1 arg2 ... argN
```

You can also use the **-N** flag with the **chwpar** command to add additional networks on a previously defined application WPAR. For example, to add a network, run the following command:

```
chwpar -N address=224.128.9.4 wpar_name
```

If you want to change the network settings for an application WPAR, use the **address** attribute to identify the network you want to change. For example, to change the netmask and broadcast address of the network at 224.128.9.3, run the following command:

```
chwpar -N address=224.128.9.3 netmask=255.255.255.128 broadcast=224.128.9.127 wpar_name
```

Related concepts

"Networking" on page 3
A WPAR can have one or more network addresses assigned to support network login and network services.

Configuring resource controls for application WPARs

You can configure the resource controls to limit the physical resources an application WPAR has access to using the **-R** flag for the **wparexec** command and **chwpar** command.

To initialize resource control settings, run the following **wparexec** command:

```
wparexec -R active=yes CPU=10%-20%,50% totalProcesses=1024 -- /path/to/application arg1 arg2...argN
```

In this example, the application WPAR is entitled to the following system resources:

- A minimum of 10% of the global environment's processors upon request
- A maximum of 20% of the global environment's processors when there is contention
- A maximum of 50% of the global environment's processors when there is no contention
- A maximum of 1024 processes at a time

The **active** attribute can be set to `yes` or `no`. When the **active** attribute is set to `no`, resource controls are disabled, but the settings are maintained in the configuration database.

For example, to change control settings dynamically for an application WPAR, run the following **chwpar** command:

```
chwpar -R totalThreads=2048 shares_memory=100 wpar_name
```

Note: You can also use the **-K** flag for the **chwpar** command to remove individual attributes from the profile and restore those controls to their default, as follows:

```
chwpar -K -R totalProcesses shares_CPU wpar_name
```

Working with specification files for application WPARs

You can create a specification file with all of the options for an application WPAR using the **-f** flag for the **wparexec** command.

If you specify the application for an application WPAR to run, including the command and all arguments, the command is not required when you create the specification file. To create a specification file for an application WPAR, run the following command:

```
wparexec -f /tmp/specfile1
```

To create a specification file as part of the WPAR creation process, run the **wparexec** command with the **-o** flag as follows:

```
wparexec -n wpar_name -o /tmp/specfile2 -- /path/to/application arg1 arg2 ... argN
```

The specification file reflects the settings being used to create the WPAR.

To generate a specification file without creating the WPAR, run the **wparexec** command with the **-w** flag and the **-o** flag:

```
wparexec -o /tmp/specfile3 -- /path/to/application arg1 arg2 ... argN
```

For a comprehensive description of the format and permitted contents of a specification file, see the `/usr/samples/wpars/sample.spec` file.

Administering WPARs

After you have a WPAR created and configured, you might want to perform tasks such as removing, restoring, and listing WPARs.

Listing WPARs

You can list summary data for system WPARs and application WPARs using the **lswpar** command.

You can list information about one or more WPARs using the **lswpar** command by specifying zero or more workload partition names. The **lswpar** command supports shell-style wildcards.

For example, to list the WPARs on a system with names that start with "mypar_", run the following command:

```
lswpar 'mypar_*'
```

Related information

lswpar command

Listing WPAR identifiers

You can list the identifiers for a WPAR using the **lparstat** command or the **uname** command.

WPARs have the following identifiers:

WPAR name
The name you assign to the WPAR.

WPAR configured ID
A dynamic identifier that is assigned each time the WPAR is started. For the global environment, the value of this identifier is 0.

WPAR key
A static identifier that is the same each time you start the WPAR. For the global environment, the value of this identifier is 0.

You can display the WPAR configured ID and the WPAR key by running the **lparstat** command with the **-W** flag. This command also displays processor information that might be helpful for licensing.

To view WPAR identification and processor information, run **lparstat** command with the **-W** flag as follows:

```
lparstat -W
```

To display the WPAR key, run the **uname** command with the **-W** flag as follows:

```
uname -W
```

Related information

lparstat command

uname command

Logging in to a WPAR

After you configure and activate a system WPAR that does not have a network connection, you can log in to it locally using the **clogin** command.

Note: The **clogin** command provides limited terminal support and some applications may not behave as they would under a full function terminal. The **clogin** command is primarily intended to be used to access the WPAR for maintenance in order to correct WPAR configuration problems. For best results, configure the WPAR to have at least a private network in order to enable network login mechanisms such as rlogin and telnet.

You can log in to a WPAR as the root user or as a different user. You might be prompted for a password when you log in. Output for the **clogin** command is displayed on the console where the command was issued. When you exit the command, the command returns to the global environment.

To log in to a system WPAR for maintenance and create a shell as the root user, run the following command:

```
clogin wpar_name
```

To log in to a system WPAR for maintenance and create a shell as a different user, run the following command:

```
clogin -l username wpar_name
```

Note: You can also log into a system WPAR remotely using the a network-based login command, such as the **rlogin** command, the **telnet** command, or the **rsh** command.

Related information

clogin command

Backing up WPARs

You can back up a WPAR using the **savewpar** command, the **mkcd** command, or the **mkdvd** command.

The **savewpar** command uses the data created by the **mkwpardata** command to back up your WPAR. If these files are not already on your system, the **savewpar** command will call the **mkwpardata** command to create these files. The image files contain the following information:

- A list of logical volumes and their sizes
- A list of file systems and their sizes
- A list of volume groups
- The WPAR name

To back up a WPAR to the default tape device, run the following command:

```
savewpar wparname
```

To back up a WPAR to a file, run the following command:

```
savewpar -f file wparname
```

You can also back up a WPAR to a CD device using the **mkcd -W** command or to a DVD device using the **mkdvd -W** command.

Related information

mkcd command

mkdvd command

mkwpardata command

savewpar command

Restoring WPARs

You can restore a WPAR using the **restwpar** command.

You can restore a WPAR from a backup image created by the **savewpar** command, the **mkcd** command, or the **mkdvd** command.

To restore the backup image from the `/dev/rmt1` device, run the following command:

```
restwpar -f/dev/rmt1
```

Related information

restwpar command

Removing WPARs

You can remove a WPAR using the **rmwpar** command.

To remove a WPAR, it must be in the defined state, and you must provide the name of the WPAR.

To remove a WPAR, run the following command:

```
rmwpar wpar_name
```

To stop a WPAR before removing it, run the following **rmwpar** command with the **-s** flag:

```
rmwpar -s wpar_name
```

Related information

rmwpar command

Starting system WPARs

You can start a system WPAR from the global environment using the **startwpar** command.

To start a system WPAR, run the following command in the global environment:

```
startwpar wpar_name
```

You can also start a system WPAR in maintenance mode. Starting in maintenance mode performs all of the actions of starting the WPAR with the exception of network configuration. You can use this flag to prevent external access to the WPAR while you perform maintenance.

To start a system WPAR in maintenance mode, run the following command in the global environment:

```
startwpar -m wpar_name
```

Note: You cannot start WPARs that rely on NFS-mounted file systems in maintenance mode.

Related information

startwpar command

Stopping WPARs

You can stop a WPAR from the global environment using the **stopwpar** command.

Stopping a system WPAR follows a similar paradigm to the **shutdown** command and the halt command for AIX. For application WPARs, running the **stopwpar** command is equivalent to removing the WPAR with the **rmwpar** command.

To stop a system WPAR in the same way that the **shutdown** command stops a system, run the following command:

```
stopwpar wpar_name
```

To stop a system WPAR quickly in the same way that the **halt** command stops a system, run the following command:

```
stopwpar -F wpar_name
```

Related information

stopwpar command

Using the Advanced Accounting subsystem with WPARs

You can use the Advanced Accounting subsystem to produce WPAR accounting reports.

Advanced Accounting produces the following records for WPARs:

- Process records
- Aggregated process records
- Aggregated application records
- File system activity records
- Network interface I/O records
- Disk I/O records
- Third-party kernel extension common aggregation records

Related information

Accounting records

Recovering incompatible detached Workload Partitions

It is possible that the system software in a detached workload partition (WPAR) may become incompatible with the levels of system software in the global environment. This occurs if software installation and maintenance tasks are performed independently in the global environment and the WPAR, or if a WPAR backup image from an incompatible system level was installed.

If you use the recommended default WPAR configuration, which shares the **/usr** and **/opt** file systems with the global environment, you will not have any incompatibility issues. The software in a shared WPAR comes from the global environment, and the **syncwpar** command provides functionality to complete any required installation operations for the WPAR.

When the system software in a detached WPAR has become incompatible with the global environment, you can use the **syncwpar -D** command to assist in recovering the incompatible detached WPAR and make it consistent with the global system. It is possible that a WPAR might ultimately remain unrecoverable, but even then it is possible to recover the non-system files in the WPAR.

Complete the following steps to recover a detached WPAR:

1. **Installation-based detached WPAR recovery**

   Use the **syncwpar** command to perform a series of installation tasks to bring the software in the WPAR to a compatible level with the global environment. If the **-d** installation device is specified, it will attempt to install software at the required levels. In order for this to be successful, the installation

media must match the levels of installation media that was used to install the software in the global environment. The **inuwpar** command is used to perform the installation operations in the WPAR.

2. **WPAR reinstallation**

   If the recovery is not successful, the only solution is to reinstall the WPAR on the system or install a backup image of the WPAR on another system with which it is compatible. The **savewpar** command can still be used to backup the WPAR, and the **restorewparfiles** command can restore selected files from the backup after a reinstallation. Alternatively, the WPAR file systems can be mounted using the following command:

   ```
   mount -t wpar_name
   ```

   The selected files can be backed up to a file or backup media using the **backup** command.

Related concepts

"Shared and non-shared system WPARs" on page 9
By default, a system WPAR shares the `/usr` file system and the `/opt` file systems from the global environment using read-only **namefs** mounts. You can configure WPARs to have non-shared, writable `/usr` file system and `/opt` file system.

Related information

syncwpar command

inuwpar command

Managing software with detached workload partitions

System WPARs exist in two basic forms as either shared or detached (non-shared /usr) workload partitions, though the file system characteristics can vary.

The shared form (shared /usr) of a system WPAR has the **/usr** file and the **/opt** file systems mounted from the global system hosting the WPAR. For shared system WPARs, all changes within the **/usr** file and the **/opt** file systems are immediately visible within the WPAR along with the installation files and information required to synchronize the non-shared (root) portion of the WPAR with the global system within the **/usr** file system. The **syncwpar** command will synchronize a shared WPAR with its global environment.

The detached form (non-shared /usr) of system WPAR has a separately installed writable **/usr** file and **/opt** filesystem. Detached WPARs provide improved flexibility by allowing the installation of different software in a WPAR than existing software in a shared WPAR environment. When it is necessary to have detached WPARs, you can use the **syncwpar** and **inuwpar** commands to manage the system software in detached WPARs and recover from situations where the WPAR has become incompatible with the global environment.

You should use shared WPARs unless it is absolutely required that the **/usr** file systems be writable within the WPAR. Detached WPARs increase administrative overhead due to the following unique operating environments:

- Operating system updates applied in the global environment are not immediately available in a detached WPAR.
- It is possible for the system software in a detached WPAR to become unusable and not boot if it is not compatible with the running kernel. This can happen simply by rejecting or applying updates in either the global environment or the WPAR, but not both.
- Installation files used to populate the non-shared (root) portion of a fileset reside in a packaging directory in the shared environment, but the files used to populate the **/usr** file and the **/opt** file systems in a detached WPAR are only on installation media. Thus, it is difficult to duplicate software installation steps that were taken in the global environment in the detached WPAR.

Related information

syncwpar command

inuwpar command

Using the trace facility with WPARs

You can use the trace facility to isolate system problems by monitoring selected system events in a WPAR.

The following tracing capabilities are available for WPARs:

- Launching a trace from within a WPAR
- Correlating a trace entry to a WPAR
- Filtering which WPAR trace entries to log from the global environment
- Filtering which WPAR entries to report from the global environment
- Running more than one kernel trace at the same time
- Additional trace utility hooks

Note: A maximum of 7 WPARs can run the trace facility at the same time.

By default you cannot run trace facility in a WPAR. To enable the trace facility from a WPAR, you must grant PV_KER_RAS privilege to the WPAR. You can grant this privilege when you run the **mkwpar** command or by running the **chwpar** command with the **-S privs+=PV_KER_RAS** flag.

Related information

trace daemon

trcrpt command

Making software available to other WPARs

When you install software in the global environment, it is not always automatically available for use within your system WPAR. You can use the **syncwpar** command or the **syncroot** command to make software available.

Application workload partitions share their file systems with the global environment and do not create new file systems. Therefore, the **syncwpar** command and the **syncroot** command are applicable only to system WPARs.

To make software available in one or more WPARs, run the following command in the global environment:

```
syncwpar wpar_name1 wpar_name2
```

The **syncroot** command performs the same function as the **syncwpar** command, but the **syncroot** command operates only within the WPAR where it is issued.

Related information

syncroot command

syncwpar command

Example: Installing Apache in a WPAR

Installing Apache allows you to take advantage of the portability and scalability of WPARs.

Before you install Apache, you must download the Apache RPM and the following dependencies:

- `expat`
- `lynx`

You can download all of these RPM files from the following Web site:

`http://www.ibm.com/servers/aix/products/aixos/linux/download.html`

To install Apache, complete the following steps.

1. Install the Apache RPM file and its dependencies in the global environment using the **rpm** command. Many of the installation images are installed in the `/opt` directory and the `/usr` directory. Because these directories are shared by the global environment and all shared WPARs, it is not necessary to install Apache separately on all WPARs.
2. Make Apache available to other WPARs.
   - If the WPAR where you want to run Apache does not exist, create it using the **mkwpar** command or SMIT.
   - If the WPAR where you want to run Apache does exist, make the installation of Apache available to the WPAR using the **syncwpar** command or SMIT.
3. Configure Apache in the WPARs where you want Apache to run. At a minimum, you should modify the *DocumentRoot* variable in the `/etc/opt/freeware/Apache/httpd.conf` file to a directory that contains the files you want to serve.
4. Start Apache in every WPAR where you want it to run.

Modified and enhanced AIX commands for WPARs

Some commands have different or enhanced behavior in a WPAR environment.

The following table shows how the behavior of some commands differs when they are run in a WPAR or run in the global environment. Some commands have different behavior only when certain flags are specified.

Note: For versioned WPARs, the **-@** flag is not recognized, because it is not present in the previous run time. Some commands in a versioned WPAR have added WPAR support, and in those cases, the behavior related to the **-@** flag is described in the following table.

Table 1. Modified and enhanced AIX commands

Command	Flags and arguments	Behavior in a WPAR	Behavior in the global environment
acctcom	- @ *WPAR name*	Not allowed in WPAR.	Executes normally displaying accounting records for WPAR named *WPAR name*.
	-@ *no argument*	Fails with `cannot open /var/adm/pacct` message	Executes normally displaying accounting records for all WPARs; a WPAR name is displayed for each record
	No -@ flag	Executes normally displaying accounting records for the WPAR	Executes normally displaying all accounting records.
accton	No -@ flag	Enables process accounting within the WPAR.	Enables process accounting within the global environment only.
	-@	Not allowed in a WPAR.	Enables process accounting for both WPAR and global processes.
audit	- @ *WPAR name*	Fails with workload partition not found message unless WPAR name is "Global".	Applies auditing command to WPAR named *WPAR name*.
clogin	-C *wpar name command*	Not allowed in a WPAR	Prompts for password and runs command in the WPAR or login if no command is specified
df		Displays information about WPAR mounted file systems only; paths are displayed relative to the WPAR root	Displays information about all file systems; paths are absolute
domainname	No flags	Displays domain name of WPAR	Displays domain name of system
	new domain name	Sets domain name of WPAR if run by WPAR root	Sets the domain name of system if run by global root
hostid	No flags	Displays host ID of WPAR	Displays host ID of system
	IP address | *hex number*	Sets host ID of WPAR if run by WPAR root	Sets host ID of system if run by global root
hostname	No flags	Displays host name of WPAR	Displays host name of system
	new host name	Sets host name of WPAR if run by WPAR root	Sets host name of system if run by global root
ifconfig	All display flags (**-a** and **-l**)	Displays information about the WPAR	Displays information about the global environment
ioo		Does not function in a WPAR	No change in behavior
ipcrm	Without -@ *argument*	Removes IPC objects associated with the WPAR	Removes IPC objects associated with the global environment
	-@ *WPAR name*	Does not function unless WPAR name is "global"	Removes IPC objects associated with WPAR named *WPAR name*

Table 1. Modified and enhanced AIX commands (continued)

Command	Flags and arguments	Behavior in a WPAR	Behavior in the global environment
ipcs	Without *-@ argument*	Displays information about IPC objects created by processes within the WPAR	Displays information about IPC objects created by processes in the global environment; no WPAR-associated objects are displayed
	-@	Displays IPC information for the WPAR where the command is run	Displays information about all IPC objects in the system; the name of the WPAR associated with the object is listed.
	-@ WPAR name	Displays no IPC information unless WPAR name is "global;" global case displays information about IPC objects associated with processes within the WPAR	Displays information about IPC objects associated with processes in the WPAR named *WPAR name*
lslpp	*-@ WPAR name*	Fails with an error message	Displays software vital product data for the specified workload partition. Fails if the workload partition is inactive.
mkclass		Only updates the `/etc/wlm` directory; fails updating kernel data	No change in behavior
mount	No flags	Displays only WPAR-mounted file systems relative to the WPAR root	Displays all mounted file systems with absolute paths
	With flags	Only NFS mounts without **cachefs** allowed	No change in behavior
netstat	**-c** **-C** **-g** **-m** **-M** **-P** **-v** **-Z**	These flags are not supported.	Display network information and statistics for the entire system
	All other flags	Display network information and statistics for the WPAR	Display network information and statistics for the entire system
	-@ WPAR name	Does not function in a WPAR	Display network information and statistics for the WPAR specified, or all WPARs if *WPAR name* is not specified
nfso		Has read-only functionality in a WPAR	No change in behavior
no	All flags except **-a**	Fails with an error message	No change in behavior if user has the correct privilege
	-a	No change in behavior	No change in behavior if user has the correct privilege
projctl	All flags except **-qproj**	Fails with a `not owner` message	No change in behavior if user has the correct privilege
	qproj	No change in behavior	No change in behavior if user has the correct privilege

Table 1. Modified and enhanced AIX commands (continued)

Command	Flags and arguments	Behavior in a WPAR	Behavior in the global environment
ps	**-e**	Displays all processes in the WPAR	Displays everything within the system; processes are not screened from view unless a specific WPAR name is specified using the *-@ WPAR name* flag
	-@	Displays process information for processes in the WPAR; WPAR name is included in output	Displays process information for all processes in the system; WPAR name is included in output
	-@ WPAR name	Displays no process information unless WPAR name is "global;" global case displays information about processes within the WPAR; WPAR name is included in output	Displays information about processes associated with the WPAR named *WPAR name*; WPAR name is included in output
	-o wpar	Produces a WPAR name header and the name of the WPAR associated with the process; name is always "global"	Produces a WPAR header and the name of the WPAR in which the process is executing
schedo		Does not function in a WPAR	No change in behavior
uname	**-n**	Displays name of the WPAR	Displays node name of the system
vmo		Does not function in a WPAR	No change in behavior
wlmstat	No flags	Displays information about the WPAR class	No change in behavior
	-@	Displays information about the WPAR class	Displays data for WPAR class
wlmtune		Does not function in a WPAR	No change in behavior
wlmcntrl		Does not function in a WPAR	No change in behavior

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing
IBM Corporation
North Castle Drive
Armonk, NY 10504-1785
U.S.A.

For license inquiries regarding double-byte character set (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

Intellectual Property Licensing
Legal and Intellectual Property Law
IBM Japan, Ltd.
1623-14, Shimotsuruma, Yamato-shi
Kanagawa 242-8502 Japan

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this

one) and (ii) the mutual use of the information which has been exchanged, should contact:

IBM Corporation
Dept. LRAS/Bldg. 903
11501 Burnet Road
Austin, TX 78758-3400
U.S.A.

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this document and all licensed material available for it are provided by IBM under terms of the IBM Customer Agreement, IBM International Program License Agreement or any equivalent agreement between us.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

All statements regarding IBM's future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

All IBM prices shown are IBM's suggested retail prices, are current and are subject to change without notice. Dealer prices may vary.

This information is for planning purposes only. The information herein is subject to change before the products described become available.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. The sample programs are provided "AS IS", without warranty of any kind. IBM shall not be liable for any damages arising out of your use of the sample programs.

Each copy or any portion of these sample programs or any derivative work, must include a copyright notice as follows:

If you are viewing this information softcopy, the photographs and color illustrations may not appear.

Trademarks

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at Copyright and trademark information at www.ibm.com/legal/copytrade.shtml.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.

Other company, product, or service names may be trademarks or service marks of others.

Index

A

active WPAR 6
Advanced Accounting subsystem 27
allocating 7
Apache
  installing 30
application
  environment 1
application WPARs 12
  configuring 22, 23
  creating 21
  file systems 12
  resource controls 23
  specification files 23

B

backing up 25

C

configuring 8
  application WPARs 22, 23
  directories 15, 22
  domain resolution 18
  file systems 15, 22
  networks 17, 22
  resource controls 19, 23
  specification files 20
  system WPARs 12, 15, 17
creating
  application WPARs 21
  system WPARs 13
customizing
  file systems 15
  system WPARs 15

D

deploying 7
device 6, 7, 8
devices 2
directories
  configuring 22
domain resolution
  configuring 18

F

file systems 8, 15
  application WPARs 12
  configuring 22
  system WPARs 9

G

global environment 3

H

host name
  system WPARs 18

I

identifiers 24
image.data file 20
inactive WPAR 6
installing
  Apache 30

L

listing 24
logging in 25

M

managing 8

N

naming
  system WPARs 12
networks 3, 17
  configuring 22

R

removing 7, 26
resource controls 5, 23
  configuring 19
restoring 26

S

security 4
software 29
specification files
  application WPARs 23
  configuring 20
starting
  system WPARs 26
stopping
  system WPARs 27
system WPARs 9, 18
  configuring 12, 15, 16, 17
  creating 13
  customizing 15
  directories 15, 16
  file systems 9, 15
  host name 18
  image.data file 20
  naming 12
  networks 17
  starting 26
  stopping 27

T

trace facility 29

Printed in USA

SC23-6720-00