About This Guide

This guide describes the basic concepts of RAID technology and provides step-by-step instructions for setting up and using Apple RAID Software on a PCI–based Workgroup Server.

You can use Apple RAID Software to mirror disks. Mirroring provides a powerful and safe way of storing data, so that even if a disk drive fails, users can access the data they need without interruption. You can also use Apple RAID Software to increase disk performance by spreading data across multiple drives and SCSI buses so that data is transferred in parallel, a technique known as *striping*.

What you need to know

This guide is intended for the person administering a Workgroup Server. Before reading this guide, you should be familiar with using the Macintosh Operating System (Mac OS). If you are new to the Mac OS, see the setup guide and administrator's guide that came with your server. The setup guide describes how to set up the server, which is a prerequisite to using Apple RAID, and the administrator's guide describes how to configure the server's system software.

How to use this guide

First, read Chapter 1 to learn about the techniques and benefits of Apple RAID. Next, decide how you want to make use of these benefits on your server. Then, plan how you'll distribute mirrored and striped volumes on the disks on your server. An Apple RAID planning worksheet in Appendix A is provided for this purpose. Read Chapter 2 to learn how to prepare disks for use with Apple RAID and how to create Apple RAID volumes on disks that are prepared for Apple RAID. Chapters 3, 4, and 5 will be of value to you throughout your use of Apple RAID, as you need to make changes to your Apple RAID volumes or as you need help with the problems that might occur.

If you want to know the meaning of a particular term, you can consult the Glossary, which provides definitions of key words used in this guide.

This guide can also be viewed on screen by double-clicking the Apple RAID Admin Guide icon located in the WS Electronic Library folder on your startup disk. The on-screen version of the guide is specially formatted for easy viewing on your screen.

For more information

Apple RAID Software Read Me See the Apple RAID Read Me file on your server's system disk or on the *Workgroup Server Software* CD-ROM disc for information about Apple RAID Software that became available after this guide was completed.

The setup guide that came with your server See this document for instructions on setting up your server and adding external disks.

The Workgroup Server Administrator's Guide See this document for instructions on setting up your server's system software. This document can also be viewed on-screen by double-clicking the WS Admin Guide icon in the WS Electronic Library folder on your server's system disk or on the *Workgroup Server Software* CD-ROM disc. The electronic version of the *Administrator's Guide* is also specially formatted for on-screen readability.

The RAIDBook: A Source Book for RAID Technology This book provides technical details about RAID technology. Copies of *The RAID Book* are available from the RAID Advisory Board, affiliated with Technology Forums Ltd., 13 Marie Lane, St. Peter, MN 56082-9423. Additional information about RAID technology is available through the RAID Advisory Board World Wide Web site; the URL is http://www.andataco.com/rab/.

Introducing Apple RAID Software

Apple RAID Software provides your Workgroup Server with a powerful and safe way of storing data, so that even if your server has a disk drive failure, users can access the data they need without interruption. (This storage technique is known as *mirroring*.) You can also use Apple RAID Software to improve performance by spreading data across several disks and SCSI buses. (This technique is known as *striping*.)

Apple RAID Software is based on a technology called RAID, which stands for *redundant array of independent disks*. This chapter describes the system requirements for using Apple RAID and the capabilities of Apple RAID.

Note: The version of Apple RAID that comes with your Workgroup Server is specifically designed to work with PCI–based servers; this version is not compatible with NuBus-based servers.

System requirements

To use Apple RAID Software, you must have:

- a PCI–based Workgroup Server from Apple Computer
- version 7.5.3 of Macintosh system software
- disk drives with a minimum of 200 megabytes (MB) of storage space each, attached to your server's built-in SCSI bus(es) or to a SCSI bus provided by one or more Peripheral Component Interconnect (PCI) SCSI cards in your server's PCI expansion slots
- virtual memory turned off

The Apple RAID drivers use approximately 400 kilobytes (K) of randomaccess memory (RAM). Be sure your system has adequate RAM to accommodate this additional requirement.

IMPORTANT Apple RAID supports the use of hard disks only; you cannot use Apple RAID on devices that support other media, such as optical or tape.

Disk drive compatibility

Disk drives are key components of Apple RAID. It's important to verify the compatibility of your hard disks *before* storing valuable data on them with Apple RAID. If a disk you wish to use follows the SCSI interface standard and is made by a reliable vendor, it should work properly with Apple RAID. However, if you are unsure whether a disk is compatible, contact the manufacturer of the disk and ask if the product has any known problems when used with Apple RAID.

Apple RAID basics

RAID functionality is divided into *levels*. For an explanation of all the levels, see Appendix B, "Levels of RAID Technology."

Apple RAID provides your server with the following capabilities:

Use mirroring when...

You need more reliable access to files and cannot afford downtime. You have enough disk space for



a duplicate copy of your data. Disk 2 Disk 3 Disk 4 *Mirroring (RAID Level 1)* simultaneously writes data to two disks. If either of the disks fails, users can continue to access data from the surviving disk.

A mirrored volume is particularly useful for mission-critical information for which downtime would be unacceptable.

For example, the patient information database at a medical clinic or the customer-support database at a 24-hour hot-line service are ideal candidates for a mirrored volume.

Use striping when...

You need faster access to large files. You want to store the data across multiple disks and SCSI buses.

	Disk 2
Disk 1	Disk 3
	Disk 4

Striping (RAID Level 0) allows the server to store successive units of data across two to four hard disks. The data is transferred in parallel on several disks, potentially yielding increased performance.

Apple RAID Software also supports *weighted striping*. On Workgroup Servers that have two or more

SCSI buses, one of which is twice as fast as the other(s), Apple RAID Software allows you to create weighted striped volumes. With weighted striping, Apple RAID sends more data to the disk that is attached to the faster bus, which significantly increases server performance.

A striped volume or a weighted striped volume would be useful for an art department or a publishing house that shares a large image or movie database and wants to access the data more quickly. The following illustration shows how mirrored and striped volumes are stored across disks and how Apple RAID appears to the users of your server and to you.



Understanding Apple RAID terminology

When you use Apple RAID, it's important to understand the difference between a disk, a partition, and a volume.

The *disk* is the physical device that stores data.

- A disk can be divided into parts called *partitions*. Each partition is a physically contiguous part of a disk. A partition resides on one disk and belongs to one volume.
- A *volume* is the logical entity that contains data. You give a name to the volume when you create it. The volume name and icon appear on the desktop. With Apple RAID, a volume can span one to four disk partitions.

The types of volumes you can create with Apple RAID are:

- standard Macintosh volumes (also known as *Macintosh HFS* volumes; *HFS* stands for hierarchical file system)
- mirrored volumes
- striped volumes
- weighted striped volumes

The illustration on the next page shows how partitions and volumes can be arranged on two hard disks.

APPLE RAID BASICS AT A GLANCE Partitions and Volumes

You need to install the Apple RAID driver on disks before you can create RAID volumes on them. A disk on which the Apple RAID driver has been installed is prepared for Apple RAID.



A 2-gigabyte (GB) and a 1.2 GB disk, prepared for Apple RAID, ready to be partitioned for Apple RAID volumes.



The same disks partitioned for three Apple RAID volumes.



Planning your system

Before you begin to create Apple RAID volumes on your server, write down how you will use the volumes to hold your data. An Apple RAID planning worksheet is provided in Appendix A for this purpose. Appendix A includes a detailed example of one system administrator's planning process and also includes a sample completed worksheet that suggests how you can plan the distribution of volumes across disks in your server system. Once you have a plan, the process of creating the volumes, as described in Chapter 2, will be much faster and easier.

2 Setting Up Apple RAID Volumes

This chapter tells you how to start the Apple RAID Setup program and use it to install the Apple RAID driver, create Apple RAID volumes and standard Macintosh volumes, and mirror existing standard Macintosh volumes.

Apple RAID is installed on your system disk at the factory, so it is available from the Apple (**é**) menu when your first start up your Workgroup Server. If you reformat your server's system disk, you need to reinstall Apple RAID on it. The files you need to reinstall Apple RAID are on the Workgroup Server Software CD-ROM disc.

APPLE RAID SETUP Overview of Creating Volumes

- **1** Use the Apple RAID Planning Worksheet to plan the distribution of Apple RAID volumes on your system.
- 2 Back up data (optional*).



3 Prepare disks by installing the Apple RAID driver on the desired disks

Setup Volume2 Starting	Search for Disks Show Partitions Install driver	Bus: A, D: 0 Site: 2.0 GB Free: 2.0 GB Free: 2.0 GB Free: 2.0 GB Bus: B, D: 1 Site: 224.1 MB Free: 113.9 MB Bus: B, D: 6 Site: 224.1 MB Free: 113.9 MB	<u>1</u>
	-		

5 Restore data to your new Apple RAID volumes (optional*).



*If you plan to mirror data of an existing standard Macintosh HFS volume, you do not need to back up the volume. When you tell Apple RAID to mirror the volume, Apple RAID will copy the data for you. If you plan to stripe data of an existing volume, you need to back up the existing data, create the striped volume, and restore the data to the new striped volume.

	Create New Volume
Volum	e Type: Mirrored - RAID 1 🔻
Select	a primary disk, then Shift-oliok to select its mirror:
\triangleright	Bus: A, ID: O, Largest free area: 2.0 GB 🏠
Þ	Bus: B, ID: 1, Largest free area: 233.9 MB
D N	Bus: B, ID: 4, Largest free area: 233.9 MB
V	Bus. B, ID. 6, Largest free area. 0
Volum	e Name : Startup
Volum	e Size : 40 MB Use Maximum
	Cancel OK



4

Preparing disks

Before you can use Apple RAID, you must install the Apple RAID driver on each hard disk drive that will contain mirrored or striped volumes. The easiest way to install the Apple RAID driver is to use the "Install driver" command. (Another way to install the Apple RAID driver is to use the Apple RAID Initialize command. For information on using Apple RAID to initialize hard disks, see Appendix C.)

IMPORTANT Once you prepare a disk to work with Apple RAID, you cannot use Drive Setup to manipulate volumes on the disk. If you try to use Drive Setup (the disk utility that comes with the Mac OS) with a disk that has been prepared for Apple RAID, Drive Setup will not recognize the disk. If you want to remove an Apple RAID volume, use the Apple RAID Setup program to do it. If, in the future, you do not want to use Apple RAID with the disk, use Drive Setup to reinitialize it.

To install the Apple RAID driver:

1 Make sure that the disks on which you want to install the Apple RAID driver are connected properly to the server and are turned on.

IMPORTANT For information on connecting a hard drive and setting the SCSI ID number, see the setup guide that came with your server. You can also see "Common Problems With SCSI Connections and SCSI ID Numbers" in Chapter 5 of this guide.

2 Turn on the server, if it's not already on.

If you want to install the Apple RAID driver on the startup disk, restart your server using a different startup device, such as the Workgroup Server Software CD-ROM disc. For details on starting up from a CD-ROM disc, see the Workgroup Server Administrator's Guide.

3 Verify that icons appear on the desktop for disks that contain Macintosh volumes.

The icons indicate that the system software recognizes your disks and that the disks are connected properly. Disks that have been initialized by a utility other than Drive Setup may not appear on the desktop. If you do not see the appropriate icons, you need to initialize the disk. For details, see Appendix C.

4 Choose Apple RAID from the Apple (**É**) menu to open the Apple RAID Setup program.

Your disks appear in the Disks (far-right) column of the Apple RAID Setup window.

If your disk doesn't appear in the column: Perhaps you forgot to turn on the disk. Turn it on and choose "Search for Disks" from the Disk menu. The disk should appear in the Disks column. A conflicting SCSI ID number among the devices on a SCSI bus will also prevent a disk from appearing in the Disks column. Check the SCSI ID numbers on the disks and refer to the setup guide that came with your server for information on the available SCSI ID numbers on the SCSI bus(es) of your server. If SCSI ID numbers conflict, shut down the server and turn off all attached disks, reset the SCSI ID number on the disk, and turn on the disks and the server. If your disk still doesn't appear, see "Common Problems With SCSI Connections and SCSI ID Numbers" in Chapter 5.

5 Select a disk in the Disks column.





6 Choose "Install driver" from the Disk menu.

In the Disks column, the icon for the disk changes to this icon:



7 Repeat step 5 and step 6 to install the Apple RAID driver on other disks that you intend to use with Apple RAID.

8 Restart the server.

On the disks that you have installed the Apple RAID driver, you can now use Apple RAID Software to create mirrored, striped, and standard Macintosh HFS volumes from the disk space that is available. (You can also mirror a standard Macintosh HFS volume that already contains data. For more information, see "Mirroring a Standard Macintosh Volume," later in this chapter.)

How much disk space is available?

The Apple RAID Setup window displays the word "Free" for each disk in the Disks column. Free indicates the largest amount of contiguous space on the disk that is available for allocation to Apple RAID volumes. You can assign the free space to mirrored, striped, and standard Macintosh HFS volumes, in any combination or arrangement you choose.



The Apple RAID Setup program keeps a running tally of the space available on a disk for Apple RAID volumes. After you create a volume on the disk, the free space diminishes by the amount of space taken by that volume. For example, if you prepare an empty 1-gigabyte (GB) disk for Apple RAID, the Disks column displays approximately 1 GB (1000 MB) of space as "Free" (a small amount of space is required for the partition map and other disk overhead). If you then create a 600 MB mirrored volume using this disk, the amount of free space is reduced to 400 MB. If you frequently create and delete volumes, your disk may have smaller blocks of free space in addition to the space indicated by "Free." For instructions on how to view all the free space on a disk, see the section "Displaying All Free Space" in Chapter 3, "Managing and Modifying Volumes."

Be careful not to confuse the free space displayed by the Apple RAID Setup program with the free space displayed by the Get Info command in the Finder. The Get Info command displays the amount of space within a volume that is not occupied by files, and the Apple RAID Setup program displays the amount of space on a disk that has not been allocated to a volume.

APPLE RAID SETUP About Mirrored Volumes

Before you use Apple RAID to set up mirrored volumes, here are a few considerations to keep in mind:

- A mirrored volume consists of two parts, the primary and mirror partitions, and these partitions must reside on different disks.
- A mirrored volume reads data from the primary partition; for best performance, that partition should reside on the faster of the two disks.
- Apple RAID volumes are limited to 4 GB, with no more than 10 Apple RAID volumes per server system.
- Apple RAID allows up to 8 partitions per disk; stripe, mirror, and standard Macintosh partitions can reside on the same disk.
- If your server has more than one SCSI bus, one partition should reside on one SCSI bus and the other partition should reside on the other SCSI bus. This way, data moves simultaneously along two paths, yielding better performance than if both partitions reside on the same bus. For better performance, you may also choose to install a PCI card that provides an additional SCSI bus. Place one partition on a built-in SCSI bus and one partition on the SCSI bus provided by the PCI card.

When possible, use two SCSI buses...

Place one partition on an internal disk and one on an external disk.



...not just one. Avoid placing both partitions on disks

that reside on the same SCSI bus.

This mirrored volume is set up on the same SCSI bus and may have reduced performance.



Creating a mirrored volume

This section describes how to create a mirrored volume on disks that have been prepared for Apple RAID.

A mirrored volume consists of two parts: a primary partition and a mirror partition. Under normal conditions, these two parts contain identical data. Maintaining identical contents in two partitions is accomplished by sending write operations (operations that write data onto the disk, such as saving a file) to both the primary partition and the mirror partition. All read operations (operations that read data from the disk, such as opening a file) go to the primary partition only. In the event that either the primary or mirror partition fails, the other partition takes over and keeps the data continuously available.

Follow this procedure to create a mirrored volume using free space on a disk prepared for Apple RAID:

- 1 If the Apple RAID Setup program is not running, choose Apple RAID from the Apple (**€**) menu.
- 2 In the Apple RAID Setup window, select a disk in the Disks column and choose New from the Volume menu.

The disk that you select will contain the primary partition of the mirrored volume. Because Apple RAID sends read requests to the primary partition, you can improve the mirrored volume's performance by selecting the faster of the two disks as the primary disk.

Shortcut: In the Disks column, select the disk to contain the primary partition. Shift-click to select the disk to contain the mirror partition. Drag your selection to an unoccupied space in the Volumes column. When you release the mouse button, the Create New Volume dialog box appears, with your selections highlighted. If you use this shortcut, you can now skip to step 5. The Create New Volume dialog box appears:

Create New Volume	
Volume Type: Mirrored - RAID 1 Select a primary disk, then Shift-olick to select its mirror: D Bus: A, ID:0, Largest free area: 2.0 GB D Bus: B, ID: 1, Largest free area: 2.33.9 MB D Bus: B, ID: 4, Largest free area: 0	— The disk that you selected is highlighted and will be the primary disk.
Volume Name: U Volume Size: 2000.3 MB Use Maximum Cancel OK	

- 3 Make sure that the Volume Type pop-up menu indicates "Mirrored—RAID 1."
- 4 Select another disk for the mirrored volume by Shift-clicking the disk.

This disk will contain the mirror part of the volume and is marked by an M. The second disk you select will be the mirror partition of the volume.



5 Type a name for the volume in the Volume Name box.

The name can be 27 characters in length and can contain any character except a colon (:).

6 Type a number in the Volume Size box or click Use Maximum.

The number you enter sets the size of the volume. It also sets the size of the partitions on each disk. For example, entering 200 creates a mirrored volume of 200 MB in size and a partition on both disks of 200 MB each, taking up a total of 400 MB of disk space on your system.

Clicking Use Maximum creates the largest volume possible on the selected disks. The size is determined by the smaller of the two free areas available. When you click Use Maximum, this size appears in the Volume Size box.

7 Click OK to create the mirrored volume.

The Apple RAID Setup program requires that the primary and mirror partitions be the same size. If you attempt to create a mirrored volume larger than possible (because the volume size is greater than the smaller of the two free areas available on the disks), an error message will appear.

The mirrored volume typically takes less than a minute to create. When the process is complete, an entry for the new volume appears in the Volumes column, as shown in the next figure. Lines between the disks and volumes indicate the disks on which the volume resides.



Mirrored volume

The volume is mounted automatically and an icon for the mirrored volume appears on the server's desktop.



Creating a striped volume

This section describes how to create a striped volume on disks that have been prepared for Apple RAID. When data is written to a striped volume, a portion of the data is written to one disk, the next portion is written to the next disk, and so on across the disks in the volume.

Use the following procedure when creating a striped volume. The example in this procedure shows placing a striped volume on three disks, though you can use from two to four.

- 1 If the Apple RAID Setup program is not running, choose Apple RAID from the Apple (**É**) menu.
- 2 Select a disk in the Disks column and choose New from the Volume menu.

Shortcut: In the Disks column, Shift-click to select all the disks that you want included in the striped volume and drag them to an unoccupied space in the Volumes column. When you release the mouse button the Create New Volume dialog box appears. If you use this shortcut, you now can skip to step 5.

The Create New Volume dialog box appears with your disk highlighted.

3 Choose "Striped—RAID 0" in the Volume Type pop-up menu.

Note: If your Workgroup Server has two or more SCSI buses, one of which is two times faster than the other(s), you can create weighted striped volumes. For more information, see the next section, "Creating a Weighted Striped Volume."

Create New Volume Volume Type: Striped - RAID 0 Shift-click to select the disks to use for this striped volume: Bus: A, ID: 0, Largest free area: 1.9 GB Bus: B, ID: 1, Largest free area: 133.9 MB	Use this menu to select the type of volume.
 Image: Second state of the second	
Volume Name : Volume Size : 1920.3 MB Use Maximum Stripe Unit Size : 100 Blocks Cancel OK	

4 Select the other disks for inclusion in the striped volume by Shiftclicking the disks.

Note: The order of partitions within the striped volume is insignificant.



5 Type a name in the Volume Name box.

The name can be 27 characters in length and can include any characters except a colon (:).

6 To set the volume size, click Use Maximum to create the largest possible volume, or type a smaller number in the Volume Size box.

The maximum size of the volume is determined by the disk with the smallest available free space multiplied by the number of disks in the volume. When you click Use Maximum, the size of the largest possible volume on the selected disks appears in the Volume Size box.

7 To use a stripe unit size different from the default setting, type a number in the Stripe Unit Size box.

The default setting is a good choice for most cases. Skip to step 8 if you want to use the default setting. Otherwise, see "About the Performance of Striped Volumes" later in this chapter for an explanation of the stripe unit and other factors that affect the performance of a striped volume.

8 Click OK to create the striped volume.

The striped volume usually takes less than a minute to create. The volume is automatically mounted and its icon appears on the server's desktop. Also, an entry for the new volume appears in the Volumes column, as shown in the following figure.



Creating a weighted striped volume

When the Apple RAID Software runs on a server that has two or more SCSI buses, one of which is at least twice as fast as the other, you can create weighted striped volumes. At most, a weighted striped volume can span two disks, one of which resides on the faster SCSI bus and one of which resides on the slower SCSI bus. When data is written to a weighted striped volume, more data is written to the disk that resides on the faster SCSI bus than is written to the disk that resides on the slower SCSI bus.

Use the following procedure when creating a weighted striped volume.

- 1 If the Apple RAID Setup program is not running, choose Apple RAID from the Apple (**É**) menu.
- 2 Select a disk in the Disks column and choose New from the Volume menu.

Shortcut: In the Disks column, Shift-click to select all the disks that you want included in the weighted striped volume and drag them to an unoccupied space in the Volumes column. When you release the mouse button the Create New Volume dialog box appears. If you use this shortcut, you now can skip to step 5.

The Create New Volume dialog box appears with your disk highlighted.

3 Choose "Weighted Striped—RAID 0" in the Volume Type pop-up menu.

Create New Volume
Volume Type: 🛛 Weighted Striped - RAID 0 💌
Shift-click to select the disks to use for this striped volume:
Bus: A, ID: 0, Largest free area: 1.8 GB Bus: B, ID: 0, Largest free area: 1.8 GB
Volume Name:
Volume Size : 1844.2 MB Use Maximum
Stripe Unit Size: 100 Blocks Cancel OK

4 Select the other disks for inclusion in the weighted striped volume by Shift-clicking the disks.

Note: The order of partitions within the weighted striped volume is insignificant.



5 Type a name in the Volume Name box.

The name can be 27 characters in length and can include any characters except a colon (:).

6 To set the volume size to a size that is smaller than the maximum possible size, type a smaller number in the Volume Size box.

The maximum possible size is determined by the amount of space available on the disk that is attached to the faster bus. Two-thirds of the volume will reside on the disk attached to the faster SCSI bus and one-third of the volume will reside on the disk attached to the slower SCSI bus.

If you type a number and then click Use Maximum, the size of the largest possible volume on the selected disks reappears in the Volume Size box.

7 To use a stripe unit size different from the default setting, type a number in the Stripe Unit Size box.

The default setting is a good choice for most cases. Skip to step 8 if you want to use the default setting. Otherwise, see "About the Performance of Striped Volumes" later in this chapter for an explanation of the stripe unit and other factors that affect the performance of a weighted striped volume.

8 Click OK to create the weighted striped volume.

8 Click OK to create the weighted striped volume.

The weighted striped volume usually takes less than a minute to create. The volume is automatically mounted and its icon appears on the server's desktop. Also, an entry for the new volume appears in the Volumes column, as shown in the following figure.



About the performance of striped volumes

The performance of a striped volume depends on the interaction of several factors and can be difficult to predict. The following information can help you choose the best setup for your striped volumes, but experimentation and experience will ultimately be your best guide.

- Speed of the disks used in the volume Disks with faster access times and faster data transfer rates provide a striped volume with better performance than slower disks.
- Performance characteristics of the disks in the striped volume Disks with similar or the same performance characteristics will perform better than disks with dissimilar characteristics.

- Number of SCSI buses used in the striped volume Multiple SCSI buses provide for better performance than putting all the disks in the striped volume on one SCSI bus. (Some Workgroup Servers come with two SCSI buses. You can add additional SCSI buses by installing PCI cards that provide SCSI buses. At most, Apple RAID can support four SCSI buses in a single Apple RAID volume.)
- *I/O size of the program accessing the striped volume* This is the amount of the data transferred to or from the disk in one I/O request. The system software and the program affect the size of this request.
- Stripe unit size A volume's stripe unit size determines where the data in a file "breaks" when written to the disks that make up the volume. The stripe unit size is an adjustable setting that can potentially increase the performance of a volume. However, in most cases, the default setting of 100 blocks provides the best results. The stripe unit size can range between 3 and 1024 blocks.
- Weighted striping Weighted striped volumes can only be created when the Apple RAID Software detects the presence of two SCSI buses, one of which is twice as fast as the other SCSI bus. When storing data in a weighted striped volume, Apple RAID Software stores two-thirds of the data on the disk attached to the faster bus and one-third of the data on the disk attached to the slower bus.

Other factors may affect the performance of striped volumes, but those listed here have the most significant impact.

Creating a standard Macintosh volume

You can use Apple RAID to create standard Macintosh HFS volumes on a disk that has been prepared for Apple RAID. One use for this type of volume is for data that you want to keep in a mirrored volume but you currently lack the necessary disk space. You can store the data in a standard Macintosh volume and when you acquire the necessary disk space, you can easily convert the standard Macintosh volume into a mirrored volume, as explained in "Mirroring a Standard Volume" later in this chapter.

To create standard Macintosh volumes using Apple RAID Software:

- 1 If the Apple RAID Setup program is not running, choose Apple RAID from the Apple (\$) menu.
- 2 Select a disk in the Disks column and choose New from the Volume menu.

Shortcut: In the Disks column, click a disk and drag it to an unoccupied area in the Volumes column. When you release the mouse button, the Create New Volume dialog box appears.

3 In the Create New Volume dialog box that appears, choose Standard Macintosh HFS from the Volume Type pop-up menu.



4 Type a name for the volume in the Volume Name text box.

The name can be 27 characters in length and can include any characters except a colon (:).

5 To set the volume size, click Use Maximum to create the largest possible volume, or type a smaller number in the Volume Size box.

6 Click OK to create the standard Macintosh volume.

The process typically takes less than a minute. When the process is complete, an icon for the volume is displayed on the server's desktop and an entry for the new volume appears in the Volumes column in the Apple RAID Setup window.



Mirroring a standard Macintosh volume

If you have a standard Macintosh HFS volume on an Apple RAID–prepared disk, you can easily create a mirrored volume for the data contained in the standard Macintosh volume. To create the mirrored volume, an Apple RAID– prepared disk with free space equal to or greater than the size of the standard Macintosh volume you plan to mirror must be connected to your server.

IMPORTANT You cannot create a mirror of data in a striped volume. Also, you cannot create a mirror of a volume if any of the files in the volume are in use. If the volume is being shared through AppleShare, quit the AppleShare application. If the volume is being shared by Macintosh file sharing, turn off file sharing.

To create a mirrored volume from a standard Macintosh volume:

- 2 In the Apple RAID Setup window, select the standard Macintosh volume you want to mirror.
- 3 Choose Create Mirrored Volume from the Volume menu.
- 4 Select a disk in the Select Mirror Disk window that has free area equal to or greater than the size of the standard Macintosh volume.
- 5 Click OK.

The Mirror Create Parameters dialog box appears:



The highest settings create the mirror most quickly, but reduce the server's performance during the process.

6 If you want to adjust the parameters for creating a mirror, move the sliders in the Mirror Create Parameters dialog box.

7 Click Create.

The Apple RAID Setup program copies the data from the standard Macintosh volume to the disk you selected. A status bar in the Setup window displays the progress of the operation. When the operation is complete, the disk containing the original standard Macintosh volume contains the primary partition and the selected disk contains the mirror. Note: The time required to complete this operation depends on the size of the mirrored volume and the performance of the disk drives on which the volume is created.

3 Managing and Modifying Volumes

Once you've set up Apple RAID volumes, you may want to use Apple RAID to mount and unmount them, to identify external disk drives, to check partition information, to delete an Apple RAID volume, or to merge free space that is not contiguous. This chapter tells you how to perform these tasks and other routine administration tasks.

Backing up your volumes

Storing data on a mirrored or striped volume isn't a substitute for making regular backups. All types of Apple RAID volumes require regularly scheduled backups to ensure data safety. Backup copies are necessary to recover from a number of situations, such as:

- You or a user intentionally or unintentionally deletes a file and then needs it back.
- A natural disaster or catastrophic accident impairs the server and requires that you re-create the server data on new equipment.
- Both disks in a mirrored volume fail simultaneously.
- Data becomes corrupted due to malfunctioning programs.
- Your server or the attached external disks are stolen.

A good backup scheme includes a hard-copy record of the contents of your server. The hard copy is your reference in case a system problem brings down your server. The record should include a short description of the information stored on your volumes and the SCSI ID numbers of the disks holding those volumes. If you use the planning sheet in Appendix A to plan the arrangement of your Apple RAID system, an updated version of it can double as your hard-copy system record.

You can use Retrospect Remote or any other standard backup utility to back up data in Apple RAID volumes.

Updating drivers

If you need to update the driver on a disk that contains Apple RAID volumes, always use the "Install driver" command in the Disk menu of the Apple RAID Setup program. Do not use Drive Setup to update the driver on a disk that contains Apple RAID volumes, even though Drive Setup allows you to do so. (Use Drive Setup with a disk that contains Apple RAID volumes only if you want to discontinue use of Apple RAID Software on that disk.)

If you reinstall system software on a disk that has been prepared for Apple RAID, you should not update the driver even though installation instructions may ask you to do so.

WARNING If you use Drive Setup to update the driver of a disk on which the Apple RAID driver has been installed, you will loose all data contained in the Apple RAID volumes on the disk.

Searching for disks

If you forget to turn on an external drive before you start up the server, volumes on that drive are not mounted automatically. You can use the Apple RAID Setup program to mount the volumes.

To mount volumes that are not already mounted:

- 1 Turn on the disk that contains the unmounted volume(s).
- 2 Choose Apple RAID from the Apple () menu to open the Apple RAID Setup program.
- 3 Choose "Search for Disks" from the Disk menu.



Any previously unrecognized SCSI hard disks are mounted for you.

Identifying external disk drives

If you want to identify external disk drives by the SCSI ID number, look at the disk access light (usually on the front of the device) while you click the disks (not volumes) listed in the Apple RAID Setup window. A disk drive's access light will flash each time you click its name in the Disks column.



In this example, taken from a Workgroup Server 8550, Bus A is the internal SCSI bus, and Bus B is the internal/external SCSI bus.

Mounting and unmounting volumes

When the icon for a Macintosh volume appears on the desktop, the volume is said to be *mounted*, or connected and ready to use. Apple RAID automatically mounts volumes when you create them. In addition, Apple RAID gives you the capability to mount and unmount volumes.
Follow these steps to mount and unmount Apple RAID volumes:

- 1 Choose Apple RAID from the Apple () menu to open the Apple RAID Setup program if it is not already open.
- 2 Select a volume in the Setup window.

3 Choose the appropriate command from the Volume menu.

You can also unmount a volume in the Finder by dragging its icon to the Trash.



Unmounting an Apple RAID volume removes it from the desktop, making its data inaccessible until the volume is mounted again.

Depending on the command you've chosen, the volume's icon should appear or disappear from the desktop. However, if Apple RAID detects a problem with the volume, the program notifies you that it cannot complete the action and provides suggestions on what the problem might be.

Displaying all free space

If you have created and deleted volumes, several partitions of free space may exist on the disk. "Free" in the Disks column of the Setup window shows the largest block of contiguous free space on the disk, but it doesn't reveal any smaller blocks of free space. To display all the free space on a disk, do the following:

1 Select the disk in the Disks column of the Apple RAID Setup window and drag it to the Volumes column.

The Create New Volume dialog box appears. It lists all the disks that have been prepared for Apple RAID. Triangles are displayed to the left of the disk icons.



2 Click the triangle next to the disk for which you want to see all the partitions.

The partitions on the disk are displayed, followed by the free areas on the disk.

Create New Uolume Volume Type: Mirrored - RAID 1 Select a primary disk, then Shift-oliok to select its mirror: Bus: A, ID: 0, Largest free area: 2.0 6B Bus: B, ID: 0, Largest free area: 0 Bus: B, ID: 4, Largest free area: 10.0 MB Personnel - Mirror - 200.9 MB Syst 2 - 23.0 MB free area: 10.0 MB Volume Name: Volume Name: Use Maximum	— This disk contains two volumes and 10 MB of free space
Cancel OK	

You can create a volume from a block of free space that is as small as 10 MB. Free areas smaller than 10 MB are best used by merging them with other free areas and then assigning the space to a volume. Though this list shows the number of free areas on the disk, it doesn't give their locations on the disk, which is necessary if you want to merge them. See "Merging Noncontiguous Free Areas" later in this chapter if you want to merge the free areas.

Checking partition information

You can expand the Apple RAID Setup window to show all disk partitions and the associated address information. To do so, follow the steps that begin on the next page: 1 Choose Show Partitions from the Disk menu of the Apple RAID Setup program (or click the button in the upper-right section of the Apple RAID Setup window).



2 To see partitions linked to a particular volume, click a volume in the Volumes column.

Clicking a disk shows how many partitions a disk has and how those partitions are linked to volumes.

- Apple RAID Setup LINKS LINKS VOLUMES PARTITIONS NIEVE Bus: A, ID: 0 Size: 2.0 GB Free: 1.6 GB Standard Macintosh Blks : 40960 (20.0 MB) First block #: 320 Startup Mac HFS - 20.0 MB ŵ 公 ŵ \bigcirc RAID 1 Primary Optimal Blks: 204800 (100.0 MB) First block #: 520310 Bus: B. ID: 1 RAID 1 - 100.0 MB \mathbb{Q} Size: 234.1 MB Drives Optimal Free: 0 RAID 1 Mirror Optimal Blks: 204800 (100.0 MB) Bus:B, ID:4 Size:234.1 MB Personnel RAID 1 - 133.9 MB Drives Optimal First block #: 320 Free: 100.0 MB RAID 1 Primary Optimal Blks: 274230 (133.9 MB) First block #: 205120 Bus: B, ID: 6 Size: 234.1 MB Free: 234.0 MB RAID 1 Mirror Optimal Blks: 274230 (133,9 MB) First block #: 320 л л
- 3 To see how a disk is partitioned, click a disk in the Disks column.

Clicking a volume shows all the partitions and disks that make up the volume.

When you no longer need to review partition information, choose Hide Partitions from the Disk menu or click the Show/Hide Partitions button.

Deleting a volume

There are several reasons why you may want to delete a volume:

- You can remove a volume you no longer need. You can then use the space for another volume.
- You can change the size of a volume. To make a volume larger or smaller, you need to delete the volume and re-create it at the new size.

After deleting a volume, the remaining disk space becomes free space, available for assignment to a volume.

Merging noncontiguous free areas

Apple RAID automatically merges contiguous free areas into one larger free area. However, it doesn't relocate free areas in order to merge them. The process of collecting free areas on a disk in order to merge them involves deleting and then re-creating volumes. Mirrored and striped volumes extend across multiple disks so this process is likely to affect several disks or even your entire server system.

To find out the location of free areas on a disk:

1 Choose Show Partitions from the Disk menu of the Apple RAID Setup window (or click the Show/Hide Partitions button in the upper-right corner of the Apple RAID Setup window).



Partition information column.

The middle column displays all partitions and lists their size and starting block number.

- 2 Use the information in the Partitions column and the information in the Create New Volume dialog box as shown in "Displaying All Free Space" earlier in this chapter to calculate the location of the free areas on the disk.
- 3 Back up the data in the volume(s) located between two areas of free space.

4 Delete the backed-up volume(s).

Once you delete the volume(s), Apple RAID merges the resulting free space with the free area next to it.

- 5 Create a new, larger volume from the enlarged free space.
- 6 Restore the backed-up data to the new volume.

Moving disks

Once you create Apple RAID volumes on your Workgroup Server's disks, keep these guidelines in mind when you want to move the disks to other systems or other SCSI buses:

- If you want to move disks that contain weighted striped volumes to other SCSI buses, you should back up all volumes before you move the disks. After you have moved the disks, you should reinitialize them, create new volumes, and restore the data from your backup tape.
- If you want to move disks that contain weighted striped volumes to another Workgroup Server that supports this version of Apple RAID, you can do so as long as that server has two SCSI buses, one of which is twice as fast as the other SCSI bus. Be sure to put the disk that was on the faster SCSI bus of the original server on the faster SCSI bus of the new server.
- If you want to move disks that contain striped volumes to different SCSI buses on the same server, you can do so. If you want to move the disks to a different server that supports this version of Apple RAID Software, you can do so. Be sure to move all the disks that contain the volume.
- If you want to change the SCSI IDs of disks after you create Apple RAID volumes, you can do so without affecting the way that Apple RAID works. (SCSI IDs should only be changed when the server is turned off.)
- If you want to move a disk to another Workgroup Server that does not support Apple RAID or that uses a previous version of Apple RAID, you should back up all volumes before you move the disk. After you have moved the disk, you should reinitialize it, create new volumes, and restore the data from your backup tape.

To delete a volume:

- 1 Select the volume in the Apple RAID Setup window.
- 2 Choose Delete from the Volume menu and click OK to confirm that you want to erase all the data contained on that volume.



Creating and deleting volumes can result in a fragmented disk, which is a disk with several areas of free space. You can better utilize your disk space by combining free areas into a larger free area that you can then assign as a volume. See the next section, "Merging Noncontiguous Free Areas," for more information.

4 Recovering From Failed Disks

An Apple RAID volume operates normally when the disks that comprise the volume operate normally. However, if one of the disks in the volume fails, you need to take action to return the disk to normal operation. This chapter describes how to recover from failed disks and volumes.

The following steps summarize how you recognize that there is a problem and what you do to recover a disk and its volume(s); each step is discussed more fully later in this chapter.

- 1. You are notified that you have a problem with an Apple RAID volume when:
- —The Apple RAID icon flashes at the top of your screen.
- —A message at system startup time indicates that a disk is missing.
- —The Apple RAID Setup window flashes icons for a volume and for a disk that has caused the failure.
- —A program displays a disk error message that it is having trouble accessing a striped volume or a weighted striped volume.
- —The Santorini Server Manager application (which is included with some Workgroup Servers) sends a message to the remote administration console about an Apple RAID volume.
- 2. Isolate the problem to a particular disk or SCSI bus.
- 3. Correct the problem with the disk or SCSI bus. If the problem persists, proceed with step 4.
- 4. If the problem is with a mirrored volume, return it to normal operation by choosing Rebuild from the Volume menu. If the problem is with a striped volume or a weighted striped volume, restore the volume from your latest backup copies.

IMPORTANT Keep current backup copies of all your Apple RAID volumes. Mirrored volumes provide the safety of offering your network users uninterrupted use of a volume when a disk fails. However, you still need to keep backup copies of mirrored volumes. Striped and standard Macintosh volumes have no built-in redundancy and of course require regular backups as well.

Notification of a problem

Apple RAID can notify you of a problem in a variety of ways. This section describes each type of notification.

Apple RAID on-screen notification

Apple RAID uses the screen to notify you that a problem has occurred. The type of notification depends on whether the problem is with a mirrored volume or a striped volume and whether the Apple RAID Setup program is running.

Notification of a problem with a mirrored volume

If the Apple RAID Setup program isn't running when the problem occurs, the system beeps once and the Apple RAID icon flashes in the Apple menu. To see information displayed in the Apple RAID Setup window, choose Apple RAID from the Apple (**¢**) menu.

🚺 File Edit

If the Apple RAID Setup program is not running, the system will flash the Apple RAID icon to alert you to open it.

If the Apple RAID Setup program is running but the Apple RAID Setup window is not the active window when the problem occurs, you'll see a flashing Apple RAID icon in the Applications menu. To see information displayed in the Apple RAID Setup window, make it the active window by choosing Apple RAID in the Applications menu.



If the Apple RAID Setup program is running but is not the active window, the Apple RAID icon flashes here. When a problem occurs, the Apple RAID Setup window flashes the icons for disks and volumes that are having problems. A short description of the problem also appears next to the name of the volume, such as "Out of Sync," as shown in the following figure.



To proceed with restoring your mirrored volumes, skip to the section "Checklist for Restoring Apple RAID Volumes."

Notification of a problem with a striped volume

If a problem occurs with a striped volume or a weighted striped volume at system startup time, an error message appears and informs you of this. If a problem occurs while the server is in use, then the program that is attempting to read or write data on a striped volume produces an error message.

Santorini Server Manager notification

Workgroup Servers that come with AppleShare also have the Santorini Server Manager application. Apple RAID Software works with the Santorini Server Manager application. Under normal operation, Server Manager displays the condition of Apple RAID as normal. If the Apple RAID Software detects an error condition, it sets an alarm condition that becomes known to Server Manager, which changes its display to indicate that the condition of Apple RAID has changed.

Apple RAID automatically clears most of its alarm conditions and notifies Server Manager. For example, when Apple RAID finishes rebuilding a volume, Server Manager learns of the new status and displays it accordingly.

For more information about the Santorini Server Manager application, see the Server Manager documentation on the *Santorini Server Manager* CD-ROM disc.

Checklist for restoring Apple RAID volumes

A number of conditions other than disk failures can cause problems with RAID volumes. Follow this checklist to rule out some of the more common causes of problems with Apple RAID volumes before proceeding with other possible solutions.

First, shut down your server and turn off external devices. Then:

- Check that the disk has a power source properly connected. Perhaps the power cord has been inadvertently pulled out of the electrical socket.
- Check that the SCSI cables are firmly connected to the disks and to the server.
- Check that a SCSI terminator is properly in place at the end of the SCSI chain.
- Make sure that the devices on a SCSI bus are assigned SCSI ID numbers that are unique among the other devices on the SCSI bus.

If these steps don't solve your problem, see either the section "Recovering a Mirrored Volume" or the section "Recovering a Striped Volume" later in this chapter.

Recovering a mirrored volume

The Apple RAID Setup window flashes the icon of the disk that is causing the problem. The Setup window also marks the affected volume as Failed, Missing, or Out of Sync. Follow the instructions in the sections below that apply to the type of problem that you are having with your disk.

A volume marked as "Failed"

Failed usually indicates that the problem is with the disk hardware. The disk controller or the head disk assembly is likely to need replacing or repair. Proceed as you would when suspecting hardware trouble on any disk drive. Try applying disk analysis tools to discern the condition of the hardware. If the disk is in satisfactory condition, you're ready to rebuild the mirrored volume onto this disk. If you're unsatisfied with the condition of the disk, rebuild the mirrored volume to another disk. Refer to "Rebuilding a Mirrored Volume" later in this chapter.

A volume marked as "Failed (primary or mirror missing)"

Missing indicates that Apple RAID cannot find the disk on your system. The most common causes for a missing disk are that the disk is turned off or disconnected from the SCSI chain of devices, or that multiple devices on the SCSI bus have the same SCSI ID number. Check for these problems and correct them. Then proceed to "Rebuilding a Mirrored Volume" later in this chapter.

A volume marked as "Out of Sync"

Out of Sync indicates that the problem with the disk is due to an ungraceful shutdown of the server. An ungraceful shutdown is a shutdown by any means other than choosing the Shut Down command or the Restart command. A common way of shutting down the server ungracefully is to turn off power to the server before choosing the Shut Down command. A power failure or an errant program can also cause an ungraceful shutdown. An ungraceful shutdown can result in a mismatch between the data stored on the primary and mirror partitions of the volume, and hence is called *out of sync*.

IMPORTANT A mirrored volume does not protect against losing data stored in a cache during an ungraceful shutdown. The Mac OS caches data, and your server programs are likely to use caches as well. (A cache increases the speed of software by temporarily storing data in RAM before writing it to a disk.) Any data contained in a cache during an ungraceful shutdown will be lost. Data in a cache lost due to an ungraceful shutdown can corrupt data in the volume, especially if the cache contained information about the size and location of files in the volume.

To recover a mirrored volume that is out of sync, use the Rebuild command as described in the next section. This method restores the volume to mirrored status quickly. It does so by copying the data on the primary partition to the mirror partition.

Rebuilding an out-of-sync mirrored volume in this way always assumes that the primary partition contains the best version of the data. If a write operation was occurring during an ungraceful shutdown, the file systems on the two partitions may be out of sync by at most one write operation. Once the rebuild is in process, you can use a standard Macintosh volume analysis utility to check for any file system corruption that may have occurred during the ungraceful shutdown.

Note: Shutting down the server ungracefully will always result in an "Out of Sync" message on the mirrored volume in the Apple RAID Setup window. A write operation at the time of the ungraceful shutdown is not necessary to produce this message. Apple RAID marks a volume as "Out of Sync" after any ungraceful shutdown, regardless of whether the data is different on the primary and mirror partitions.

Rebuilding a mirrored volume

If either disk used in a mirrored volume fails or is accidentally turned off, your network users continue to have access to the data on the volume because Apple RAID automatically uses the disk that is working. You should rebuild the volume as soon as possible because until you do, you are running without the safety of the mirror. If the working disk develops a problem, users will lose access to the data.

To rebuild a mirrored volume, follow these steps:

1 Choose Apple RAID from the Apple () menu to open the Apple RAID Setup program.



The Apple RAID Setup window appears.

If the Apple RAID Setup program can locate the failed disk drive, it flashes that drive in the Disks list; otherwise, it flashes the volume icon and indicates that the volume is failed (primary or mirror missing).

2 Select the failed (flashing) volume in the Volumes list.

3 Choose Rebuild from the Volume menu.



The Select Mirror Disk dialog box appears if the disk failed or is missing. If the disk is out of sync, this dialog box does not appear. For disks that are out of sync, skip to step 5.

	Select Mirror Disk Select the disk to use as the mirror.	
⊳	Bus : A, ID : O, Largest free area : 2.0 GB	4
	Bus: B, ID: 0, Largest free area: 100.0 MB	U.
₽	Bus : B, ID : 5, Largest free area : 76.2 MB	
	<u>र</u>	۶
	Cancel OK	

4 Select a disk to replace the failed or missing disk and click OK.

The following dialog box appears.



The highest settings give the quickest rebuild, but reduce the server's performance during the process.

5 If you want to adjust the settings for rebuilding the volume, move the sliders in the Volume Rebuild Parameters dialog box.

6 Click Rebuild.

The Apple RAID Setup program builds a new mirrored version of the data from the partition that is functioning. A status bar appears below the volume name in the Setup window.

WARNING Do not update the Apple RAID driver while a mirrored volume is being rebuilt.

At this point, you can quit the Apple RAID Setup program. The volume can be used while it's being rebuilt—Apple RAID continues to read and write to the volume while rebuilding is in progress. If you need to reset the rebuild rate while the volume is being rebuilt, choose "Change Rebuild Rate" from the Volume menu of the Apple RAID Setup program.

If you need to restart the server during the rebuild process, you can do so. Apple RAID remembers the point at which the rebuild process was interrupted and resumes the rebuild process when the server restarts.

Recovering a striped volume

The server treats a striped volume as if the volume's data were located on one disk, even though the data is located on two to four disks. As with any volume, if one of the disks on which a striped volume or a weighted striped volume resides is disconnected, missing, or has a hardware failure, you'll experience problems with the volume. The only difference with a striped volume or a weighted striped volume is that there is a greater chance of experiencing a disk problem due to the increased number of disks in a striped volume.

Any time you experience a problem with a striped volume or a weighted striped volume, you need to consider the possibility that data corruption has occurred. Data corruption happens when data is written to the volume after a problem arises. An exception is if you're alerted to a problem with a striped volume or a weighted striped volume when you start up the server and find that you've neglected to turn on a disk. You don't need to check for data corruption in this instance; simply turn on the disk and choose "Search for Disks" from the Disk menu of the Apple RAID Setup program.

Check for data corruption to a volume by using a standard Macintosh volume analysis utility. If you find data corruption on the volume, restore the volume from a backup copy.

If you cannot restore a missing partition, such as by turning on a disk or resetting a SCSI ID number, you need to re-create the entire volume from your backup copy.



Recovering from a problem on a disk that contains mirrored and striped volumes

When you experience problems with a disk that contains both a mirrored and a striped volume (or a weighted striped volume), treat the problems individually. Follow the instructions in this chapter to recover a mirrored volume and to recover a striped volume.

Recovering from a failed disk and an ungraceful shutdown

If you experience a failed disk and then shut down your server ungracefully, treat the situation as if you were treating a problem with a failed disk. If your disk contains a mirrored volume, you will need to rebuild the volume using the Rebuild command. For more information, see "Recovering a Mirrored Volume" earlier in this chapter. If the disk contains a striped volume or a weighted striped volume, re-create the volume from your latest backup copy. For more information, see "Recovering a Striped Volume" earlier in this chapter.

5 Troubleshooting

General advice

Attempt to isolate a problem you've encountered to the various components of your server: the external disks, the CPU or the internal disks, the system software, or a program such as Apple RAID or AppleShare. Isolating the problem will increase your efficiency in solving the problem.

If your server and the attached devices have been functioning properly until recently, determine what parts of the server and its software have been modified by any recent changes to the system. Very often, the problem the server is having is related to the recent changes.

If the problem is with an external disk, see the manual(s) that came with the hardware for more information in determining how to solve the problem.

If the problem is with the server and its internal disks or system software, see the setup guide that came with your server for additional information on identifying and solving the problem.

Common problems with SCSI connections and SCSI ID numbers

Often what appears to be a problem with a server is actually due to a SCSI device that has been attached incorrectly. The following procedure describes how to connect devices to your chain of SCSI devices correctly, and it also points out the common things that can go wrong. Always check the manuals that came with your SCSI devices, as they may contain additional steps to those given here.

- 1 Shut down the server and turn off its power.
- 2 Turn off all external SCSI devices.
- 3 Check your cables and connectors for the following trouble and make any necessary changes or replacements.

Are all power cords and SCSI cables fitted snugly so that moving a device will not inadvertently loosen the cord or cable?

Are all cables on the SCSI chain from the same vendor? If they aren't, this may be a problem.

Do the cables have the proper electrical shielding?

Are the cables free of cuts or abrasions? If they aren't, replace the cables. Are any of the 25 pins bent or missing on the connector that attaches to the back of the server? If they are bent or missing, replace the connector. Is there a terminator on the last device in the SCSI chain only? If there isn't, you need to add one. If there are terminators elsewhere on the SCSI chain, you need to remove them. The presence of more than one terminator on a SCSI chain can cause devices on that SCSI chain to behave unpredictably. Note that terminators can be external or internal. Check the documentation that came with your device to see if it has an internal terminator.

Is the SCSI cable between your server and all attached devices longer than 6 meters or 20 feet? If it is, shorten it. Choose the shortest SCSI cable available that will meet your needs. The farther an electronic signal must travel down a cable, the more opportunity for a distorted signal.

Are you using shielded SCSI cables? Unshielded cables are often the cause of SCSI problems. They can also decrease server performance by causing failed requests that must be retried. All Apple SCSI cables are shielded. A shielded cable is thicker and stiffer than an unshielded cable. Check with the manufacturer if you're unsure whether the cable is shielded. The longer your SCSI chain is, the more problems may occur, especially when unshielded cables are used.

4 Make sure the SCSI ID numbers are set properly for every external device.

Do you have two or more devices on one SCSI bus set to the same SCSI ID number? If you do, you need to reset the numbers so that each device has a unique number on the SCSI bus. (If your server has more than one SCSI bus, devices on different SCSI buses can have the same SCSI ID number.) For information about the SCSI ID number of the devices that are installed at the factory, see the setup guide that came with your server.

Is the SCSI ID selector snapped securely into place? If it isn't, you need to adjust it. The SCSI ID selector must be in a position for a specific ID rather than halfway between two numbers.

5 Turn on all SCSI devices and allow several seconds for the disk drives to spin.

- 6 Turn on your server.
- 7 Verify that all attached SCSI devices that contain Macintosh volumes appear on the desktop and function as expected.

If you have gone through steps 1–6 and your system still won't start up, or some devices won't start up, shut down the server and remove all external devices. If the server fails to start up with no devices attached, there is likely a problem with the server. Contact your Apple-authorized service provider. Your service provider will examine the internal components of the server for possible defects.

Add the devices back to the server one at a time, being sure to place the terminator on the last device in the SCSI chain. Start up the server after each added device and see if the server and the device start up. This process will eventually uncover the errant device.

Sometimes a device will fail when it is at one position on the SCSI chain but will function when placed at another location. If your system still won't work, try reordering the devices.

See "Solving Hard Disk Problems" in Chapter 7 of the *Workgroup Server Administrator Guide's* for additional procedures that can help you isolate hard disk drive problems.

If you have exhausted the above options and your system still won't work, contact your local Apple-authorized service provider if you suspect a hardware problem. A skilled technician with experience and diagnostic tools may be required. If you suspect a software problem with an Apple product, contact Apple for assistance. See Appendix C in the *Workgroup Server Administrator's Guide*.

Solutions to typical problems

A disk that contains one or more mirrored volumes fails repeatedly.

A mirrored volume may fail for no apparent reason and rebuild with no problem, pass disk test utilities, and then fail again within a few weeks. If a disk begins to experience repeated spontaneous failures, it is likely to experience an unrecoverable hard failure soon. You should consider replacing the disk as soon as possible.

The disk does not appear in the Apple RAID Setup window.

If you forgot to switch on the disk, turn on its power and choose "Search for Disks" from the Disk menu. The disk should appear in the Disks column. A conflicting SCSI ID number among the devices on the same SCSI bus will prevent a disk from appearing in the Disks column. Check the SCSI ID numbers on the disks and refer to the setup guide that came with your server for information on the available SCSI ID numbers on the SCSI bus(es) on your server. If a number is conflicting, shut down the server, turn off the disk, reset the number, turn on the disk, and start up the server.

You installed a non–Apple RAID driver on a disk that contains Apple RAID volumes.

You can retrieve your volumes if the Apple RAID partition map is intact. Start the Apple RAID Setup program, select the disk, and choose "Install driver" from the Disk menu. If "Install driver" is dimmed, the Apple RAID partition map has been damaged and no recovery is possible; you need to reinitialize the disk.

The disk behaves unreliably.

The drive's read-only memory (ROM) may need to be upgraded. Check with the drive's manufacturer to see if a ROM upgrade is available.

Apple RAID shows no free area on your disk, and you know the disk is empty.

Your disk probably was initialized with a program other than Drive Setup or Apple RAID. An initializing program other than Drive Setup or Apple RAID may put an incompatible partition map on the disk. Though the disk is empty, it is not partitioned for use with Apple RAID and therefore has no space free for Apple RAID. Initialize the disk with Drive Setup and install the Apple RAID driver (as described in Chapter 2), or initialize the disk with Apple RAID (as described in Appendix C).

Your volume does not appear in the Volumes column of the Apple RAID Setup window.

This problem will occur if you remove from the server the disk containing the volume. You need to return the disk to the server system.

When creating a new volume, the Apple RAID Setup program will not accept the volume size you are trying to enter.

The size you typed is larger than the free space available on one or more of the disks included in the volume. Or, the number you typed is out of the allowable range for a volume. A volume must be larger than 10 megabytes and smaller than the maximum size set by the Mac OS, which for system software version 7.5.3 is 4 gigabytes. For a weighted striped volume, the drive on the faster bus provides a larger portion of the space than the drive on the slower bus.

When creating a new volume, the Apple RAID Setup program will not let you select the type of volume you want.

The Apple RAID Setup program checks the number of disks or partitions you have selected in the Disks column. A standard Macintosh volume can have only one disk or partition selected, and a mirrored volume must have two disks or partitions selected.

When creating a new volume, the Apple RAID Setup program does not let you select more than one partition on the same disk.

When creating a striped volume, each stripe must be on a different disk. For a mirrored volume, the primary and the mirror partitions must be on different disks.

The Apple RAID Setup program rejects your choice for the target of a rebuild operation.

The Apple RAID Setup program will not let you create a new mirror partition on the same disk that contains the primary partition. Also, you cannot rebuild a volume to a disk that has not been prepared for Apple RAID. Select a different disk.

When trying to rebuild a failed mirrored volume, the Apple RAID Setup program starts the rebuild but then shows that the rebuild failed.

The disk that is the target of the rebuild is inoperative. Check the cables and power. If no problem can be detected, remove it from your system and rebuild to a different disk.

While rebuilding a mirrored volume, your server runs too slowly.

If you are rebuilding a volume while doing other work on your server, the rebuild process is taking too much of your server's time. Choose "Change Rebuild Rate" from the Volume menu of the Apple RAID Setup program. Use the sliders to adjust the rebuild process so that it runs more slowly. This will give you better performance for the other work on the system. If you find that the rebuild process is running too slowly, adjust the rebuild process to run more quickly, which will degrade performance for the other system work. For information on adjusting the rebuild rate settings, see "Rebuilding a Mirrored Volume" in Chapter 4.

Another way to reduce the time it takes to recover a mirrored volume is to connect to your server an empty disk that has been prepared for Apple RAID. (The disk must be large enough to hold the partition that is being mirrored.) Having an empty disk is recommended, but it is not required.

You cannot create or delete volumes because these commands are dimmed in the menu; you can only mount or unmount volumes.

The Apple RAID Setup program does not allow the creation or deletion of volumes while a volume is being rebuilt. Wait for the volume to rebuild and then you can create new volumes and delete existing ones.

You cannot create a mirrored volume from a standard Macintosh volume.

You will be prevented from making a mirror of a standard Macintosh volume if any of the following conditions are true:

- The Macintosh volume is shared through AppleShare or Macintosh file sharing.
- Files on the volume are in use.

You want to reinitialize an Apple RAID disk so that it can be used with a computer that does not support Apple RAID.

Use the Apple RAID Setup program to unmount the Apple RAID volumes. Then use Drive Setup or a third-party disk utility to reinitialize the disk.

The server crashes after you initialize a disk with Apple RAID.

If a disk loses power while it is being initialized with Apple RAID, your server may crash immediately or it may crash later during normal operation. If you suspect that your server is crashing because a disk lost power while it was being initialized, start up your server with the offending disk off. Then turn the disk on, and initialize it with Drive Setup or a third-party disk utility. If this initialization is successful, install the Apple RAID disk driver or reinitialize it with Apple RAID. If this initialization is not successful, the disk is probably ruined because of interruption of the initialization process.

Drive Setup does not display information about Apple RAID volumes.

Drive Setup does not recognize Apple RAID mirrored or striped volumes, but it does recognize standard Macintosh volumes that have been created by the Apple RAID Setup program.

The server's performance degrades and you cannot create new Apple RAID volumes.

Setting your server's monitor for thousands or millions of colors may degrade the performance of Apple RAID and prevent it from creating volumes. Use the Monitors & Sound control panel to set 256 colors or less.

Your server crashes when you run a particular screen saver.

Some screen savers perform many complex calculations to draw a single picture on the screen. Because these calculations require a significant amount of CPU time, complex screen savers reduce the performance of your Workgroup Server. Use a simple screen saver.

Some screen savers or their modules are not compatible with Apple RAID Software and can cause your Workgroup Server to crash or become frozen. Before purchasing a screen saver, check with the screen saver's manufacturer to determine if the screen saver will work properly with your Workgroup Server and with Apple RAID.

After using a backup utility to restore an Apple RAID volume, it appears as a generic hard disk icon.

To recover the Apple RAID volume icon:

- 1. Click (select) an Apple RAID volume icon of the same type as the restored volume.
- 2. Choose Get Info from the Finder's File menu, click the icon in the Get Info window, and choose Copy from the Edit menu.
- 3. Select the Apple RAID volume that has the generic icon.
- 4. Choose Get Info from the Finder's File menu, click the icon in the Get Info window, and choose Paste from the Edit menu.

The icon is restored.

Your server takes a long time to start up.

Some 2 GB disks take a long time to reach full speed. Apple RAID causes your server to wait for such disks to spin up, which may mean that your server takes longer to start up after you begin using Apple RAID.

There is no disk activity during the rebuild of a mirrored volume.

If there appears to be no disk activity during a rebuild, the rebuild may be stalled. Restarting the server should cause the rebuild to continue.

The rebuild of a mirrored volume fails.

If a rebuild failure occurs, check that all devices on the SCSI bus are properly attached, terminated, and turned on. Retry the rebuild with the rebuild rate slider set to less than 75% of maximum.

Appendix A Apple RAID Planning Worksheet

This appendix includes an example of how one administrator planned to use Apple RAID. Here's the best way to use the worksheet in this Appendix:

- 1 Read Chapter 1 to familiarize yourself with Apple RAID Software and to learn about the advantages and requirements for mirrored and striped volumes.
- 2 Read the account of planning and setting up Apple RAID volumes in this appendix.
- 3 Photocopy the blank worksheet at the end of this appendix so that you will have extra copies at hand for reworking your Apple RAID setup.
- 4 Using the filled-in sample worksheet as a guide, complete a copy of the provided blank worksheet to establish the size and distribution of your Apple RAID volumes.

Keep a photocopy of the final version of your worksheet for later reference. A hard-copy list of a server's organization and summary of contents can come in handy in the event that you lose a RAID volume and need to recreate it from backup copies.

Planning for Apple RAID: An example

Terry works at a medium-sized auto dealership that recently purchased a Workgroup Server. Terry has read Chapters 1 and 2 of this guide and is now ready to plan how the dealership's data can be set up effectively as Apple RAID volumes.

What type and size should each volume be?

Terry knows the different groups of employees at the dealership as well as how they use the business's data and is able to determine the type of Apple RAID volume that would benefit each group the most. Terry selects a volume type (mirrored, striped, or standard) and determines how large each volume should be, taking into account the current data and future growth.

Each of the volumes Terry wants to create is described below. Terry's decision about what type and size of Apple RAID volume best suited for the data is indicated at the end of each of the descriptions. After listing the volumes by name (step 1 on the example worksheet later in this appendix), Terry enters the size of the volume (step 2 on the worksheet example).

Marketing

The dealership has a small marketing group that is responsible for creating magazine and newspaper advertisements. The group uses computers to lay out ad copy, which may include digitized images. The expense of doubling the disk space for this data that mirroring would require cannot be justified, so Terry considers the possible increase in speed a striped volume may provide for accessing large graphics files. The marketing group has frequently asked for more server storage space, so Terry assigns "Striped" as the volume's type and 3200 megabytes (MB) as its size.

The Shop

The service department relies on a comprehensive database of car parts. Many people use this database, and customer satisfaction depends on its availability. Terry assigns "Mirrored" as the volume's type and 800 MB as its size.

Accounting

The accounting department keeps records of all the cars on the lot. The sales employees need uninterrupted access to this information seven days a week so that they can close sales. Terry assigns "Mirrored" as the volume's type and 800 MB as its size.

E-mail

Terry is concerned that the E-mail server software that the dealership uses is prone to failing. Coworkers have grumbled that the E-mail system seems to be down frequently. Terry recognizes that a mirrored volume may increase the availability of E-mail and assigns "Mirrored" as the volume's type and 200 MB as its size.

Applications

Terry has installed software-license management software to reduce software expenses. Terry needs a place to store application programs that have been altered so that they can check the license-management program for an available license at startup time. Terry considers striping this volume for the potential added speed when copying large applications. Striping also seems appropriate because the data is generally static and changes only when new software programs are added. Terry assigns "Striped" as the volume's type and 1200 MB as its size.

Sys1 and Sys2

Terry feels that creating a striped volume in which to place the System Folder is too risky; the multiple disks used in a striped volume increase the probability that a disk, and thus the striped volume, will fail. Though mirroring is a good option for the System Folder, for now, Terry decides to use a standard Macintosh volume. Because problems with software incompatibility have been experienced, Terry decides to create two startup volumes: one volume to contain a backup copy of system software prior to installing new software, and the other volume to contain the new software. That way, Terry can always go back to the old configuration if necessary. Terry assigns "Standard" as each volume's type and 100 MB as each volume's size.

What is the required disk capacity?

Terry is now ready to see how much disk space the planned volumes will occupy. Terry subtotals and multiplies by 2 the space required by the mirrored volumes to allow for the redundant copies and enters the total, 1800 MB on the planning worksheet (step 3). Terry then totals the size for striped and standard volumes. Next, Terry adds all the totals together to determine the minimum amount of disk space for the entire server system (step 4), which turns out to be 8200 MB. Terry knows that more than this minimum amount of space will be necessary because disk drives are available only in certain sizes. Terry also wants a flexible system that can grow as business needs change.

Where should the volumes be located?

The next part of Terry's planning process is to determine which disks will hold the volumes that have been planned. This information is entered in the section of the worksheet titled "Assigning Partitions for Apple RAID Volumes."

Terry's Workgroup Server has an internal/external SCSI bus to which a 4-gigabyte (GB) disk drive and a 1 GB disk drive are connected. Terry's server also has a Peripheral Components Interconnect (PCI) card that provides another SCSI bus to which a 4 GB disk drive and a 2 GB disk drive are connected. Terry records the two SCSI buses at the top of the partition portion of the worksheet (step 5).

For each of the disks in the server system, Terry writes down the total capacity of the disk underneath the SCSI ID number (step 6). For the internal/external bus, Terry marks as unavailable SCSI ID 3 because it is used by the CD-ROM drive on the server. Terry assigns a 4 GB disk and a 1 GB disk to the internal/ external bus, choosing SCSI IDs 0 and 1 for these disks. Terry assigns a 4 GB disk and a 2 GB disk to the SCSI bus provided by the PCI card.

Terry is now ready to assign partitions on the disks for each of the volumes using these guidelines:

- A disk can have up to 8 partitions; a server can have up to 10 RAID volumes.
- A volume can be up to 4GB in size
- The partitions should be spread across both SCSI buses when possible.
- The partitions for mirrored and striped volumes must be the same size.

Terry has decided to create a striped volume for Marketing and to spread it across the four disks. To determine the size of each partition in the volume, Terry divides the volume size (3200 MB) by the number of disks used in the volume (4) and enters the total for each partition (800 MB) on the planning worksheet (step 7). Terry also subtracts the partition size from the free space for each disk to keep a running total of the remaining space on each disk (step 8).

For the mirrored volume The Shop, Terry assigns two partitions, each the size of the complete volume (800 MB). Terry places one partition on the internal/external bus and one on the PCI bus. Again, Terry subtracts the partition size from the disk size to keep a running total of the available free space on each disk.

Terry continues to assign partitions for each of the volumes that have been planned.

Adjusting the Apple RAID configuration and server system

Terry notices a few weaknesses in the plan. For instance, the 4 GB disk on the internal/external SCSI bus is underutilized, and the E-mail mirrored volume is not spread across two SCSI bus. Finally, one of the striped volumes uses two disks and for maximum performance gains Terry would like to use three or four disks.

If desired, Terry can work out another configuration on paper and make adjustments before implementing Apple RAID. The planning sheet also can help Terry reassess disk storage space requirements and determine whether additional disks need to be purchased.

Terry's worksheet example

The following worksheet shows how Terry planned to use Apple RAID on the server.

Apple RAID Planning Worksheet	Selecting Volume Types and	d Sizes												
	Volume name	Volume type and	l size											
		Mirrored	Striped	Standard										
	 Marketing 		3200 MB											
 List your volumes in this column. 	The Shop	800 MB												
2 Choose mirrored, striped, or standard for each volume and enter its size.	Accounting	800 MB												
	E-mail	200 MB												
	Applications		1200 MB											
	Sys 1			100 MB										
	Sys 2			100 MB										
3 Enter the subtotal for mirrored volumes and														
multiply by two.	Subtotal	1800 MB x 2												
4 Enter the column totals and add them together to arrive at the minimum required disk capacity.	TOTAL (Minimum required disk capacity)	3600 MB	+ 4400 MB +	· 200 MB	= 8200 MB									
Assigning Parti	tions f	or Appl	e RAID	Volun	nes									
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	SCSI bu	us: Int(ernal/E	xternal	/			SCSI b	us: PCI					
SCSI ID number	0	٢	2	3	4	5	ۅ	0	1	2	3	4	5	6
Capacity in MB:	4000	1000		N/A				4000	2000		9 /	Enter the	SCSI bus.	
Marketing	800	800		ij			/i	800	800			Enter the	dict's range	, io
Volume The Shee	3200	5002	$\left \right $		$\left \right $			3200	1200		2	under the	disk's SCS	
Volume	2400						/i	2400		- - - /		Enter part	tition sizes	for a
Accounting	800						į	800			/ [volume or disks. Mal	n the appro ke sure you	priate
E-mail								500	200			enter a nu partition ir	umber for e n a volume.	ach
Volume								1400	1000					
Applications						 		009	009	/ 	∞ /	Enter the remaining	free space I after	
Volume								800	400			subtractin	g the partit	ion
Sys1	100											size from	the disk ca	pacity.
Volume	1500													
Sys 2		100												
Volume		100+									tut Lie	te space av ure volume	vailable for ss.	
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Some SCSI ID numbers are not available on certain buses. For details, see the setup guide that came with your server.

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		Standard							+
	d size	Striped							
l Sizes	Volume type and	Mirrored						x 2	Ŧ
Selecting Volume Types and	Volume name	•						Subtotal	TOTAL (Minimum required disk capacity)

Assigning Parti	tions fo	or Appl	e RAID) Volun	nes									
	SCSI bu	IS:						SCSI bu	s:					
SCSI ID number	0	-	2	3	4	5	9	0	1	2	3	4	5	9
Capacity in MB:														
	1010 400 0	10blo 00 00	o o o o o o o o o o o o o o o o o o o	C Los Jots	di occolic	10 or 1400 or	o todt obi	. 441111 0000	40) 1400 ATTO					

Some SCSI ID numbers are not available on certain buses. For details, see the setup guide that came with your server.

Appendix B Levels of RAID Technology

RAID technology involves *levels* of functionality. These levels are not additive; for example, Level 2 is not an enhancement of or addition to Level 1. RAID standards are set by an international advisory board that serves as the main source for specific RAID information. The goals of RAID are essentially twofold: to protect data from loss during a disk failure and to enhance the speed of data storage and retrieval. Advanced levels of RAID technology are often embedded in the hardware of a system. Apple RAID implements Level 0 and Level 1.

The levels of RAID in use today are:

- Level 0, *disk striping for better performance* Provides low-cost, improved I/O performance, especially for programs with numerous small or sequential I/Os and for large segmented files, such as graphic images, by storing pieces of files on more than one disk; this level does not provide data redundancy.
- Level 1, *disk mirroring for redundancy and reliability* The system stores the identical data on two different disks.
- Level 2, *redundancy through Hamming code* Special code detects and corrects errors during parallel transfers to and from disks; primarily used in supercomputer systems.
- Level 3, *disk striping plus redundancy* Uses one dedicated disk for parity checking with improved sequential performance in the drives but reduced I/O performance.
- Level 4, *striping, redundancy, and simultaneous I/O* Still requires one disk for parity checking, but improves performance in multitasking systems.
- Level 5, *striping, redundancy, and simultaneous I/O* Parity and data are striped across all disks. Lost data can be reconstructed. Offers enhanced performance especially for programs with numerous small I/O operations.

Appendix C Initializing Hard Disks

You can use Apple RAID to initialize hard disks on which you plan to create mirrored or striped volumes. (You can also use Drive Setup to initialize hard disks and then use Apple RAID to install the Apple RAID disk driver, as described in Chapter 2.)

Initializing a hard disk destroys any data that the hard disk may contain. If the hard disk contains data that you want to save, you should back it up before you begin the initialization process. This appendix tells you how to back up data in a way that makes it easy to restore once you have created mirrored or striped volumes and tells you how to use Apple RAID to initialize a hard disk.

Backing up data

Use Retrospect Remote or some other program to back up the data on the disks that you will be initializing with Apple RAID. When you restore the data onto your newly created Apple RAID volumes, it will be easier if you back up the files according to how you will restore them. For example, back up the files destined for a mirrored volume, then back up the files destined for a striped volume.

If you are running AppleShare on your server, have it running when you use Retrospect Remote to back up the volume that contains it. This is necessary to back up your AppleShare Permissions file. You'll want to have a backup of the Permissions file in order to restore it later. For information on using AppleShare, see the manual that came with it.

Steps to initialize disks

Initialize enough disks for use in the mirrored or striped volume. A mirrored volume requires two disks and a striped volume requires a minimum of two disks and can include as many as four disks.

- 1 Turn on the external disks that you will be initializing.
- 2 Turn on the server, if it's not already on.
- 3 Verify that icons appear on the desktop for disks containing Macintosh volumes.

The icons indicate that the system software recognizes your disks and that the disks are connected properly. Disks that have been initialized by a utility other than Drive Setup (Apple Computer's disk utility) may not appear on the desktop.

4 Choose Apple RAID from the Apple () menu to open the Apple RAID Setup program.

The Setup window appears and lists your disks in the Disks (far-right) column.

If your disk doesn't appear in the column: Perhaps you forgot to turn on the disk. Turn it on and choose "Search for Disks" from the Disk menu. The disk should appear in the Disks column. A conflicting SCSI ID number among the devices on a SCSI bus will also prevent a disk from appearing in the Disks column. Check the SCSI ID numbers on the disks and refer to the setup guide that came with your server for information on the available SCSI ID numbers on the SCSI bus(es) of your server. If SCSI ID numbers conflict, shut down the server and turn off all attached disks, reset the SCSI ID number on the disk, and turn on the disks and the server. If your disk still doesn't appear, see "Common Problems With SCSI Connections and SCSI ID Numbers" in Chapter 5.

5 Select a disk in the Disks column.



If you select a volume instead of a disk, the Initialize command will be dimmed. The Initialize command can initialize an entire disk only, not part of a disk.



Initialization takes approximately 15 minutes for a 230 MB disk and longer for larger disks. You cannot cancel the initialization process once it begins.

WARNING Do not interrupt the initialization process by turning off or disconnecting the disk. Doing so may damage the disk in a way that prevents it from being initialized by any disk utility. If the power to the server is interrupted while Apple RAID is initializing a disk, restart the server and restart the initialization process. See Chapter 5 if you experience problems with a disk whose initialization process was interrupted.

In the Disks column, the icon for the disk changes to this icon:



7 Repeat step 5 and step 6 to initialize another disk.

You can now create mirrored, striped, and standard Macintosh volumes on the disks that you have initialized with Apple RAID.

6 Choose Initialize from the Disk menu.

Glossary

disk driver Software that provides an interface between the operating system and the hard disk. The operating system includes the disk drivers for commonly used disks. If your hard disk is delivered with a disk driver, and the disk is not recognized by your server, you probably need to install the disk driver. The disk manufacturer should provide information on this.

failed A disk is termed *failed* when the server is unsuccessful in locating or reading from the disk. A disk failure can be caused by lack of power to the disk (the power cord is unplugged), faulty hardware within the disk drive, or one of the parts from a mirror or striped volume is not found by the Apple RAID software.

external drive A disk drive that resides outside the server instead of inside of the CPU box. An external drive is housed in its own casing and attached to the server through a SCSI cable.

format See initialize.

free area Disk space that is available for assigning to a volume.

HFS Abbreviation for *hierarchical file system*. Macintosh computers use volumes initialized for HFS.

hard disk drive A device used for storing binary data. It consists of disks, also called platters, that rotate.

initialize To prepare a disk for use with a particular operating system.

internal bus A SCSI bus to which devices inside of the server can be connected. The Workgroup Server 8550 has an internal bus, but the Workgroup Server 7250 does not.

internal/external bus A SCSI bus on which external peripheral devices are connected to the server. On the Workgroup Server 8550, devices both inside and outside of the server can be connected to the internal/external bus.

levels of RAID The levels of functionality available in RAID technology. See Appendix B in this guide.

mirror In Apple RAID, a mirrored volume contains identical data on two partitions on two disks. This is accomplished by directing all write operations to the two disks. The mirror partition is the standby copy, and the primary partition is the one accessed by all read operations to the volume.

mirroring In Apple RAID, a technique by which the same data is written to two disks in order to have a standby copy if either disk fails.

mirror partition The partition in a mirrored volume that contains the redundant version of the data. See also **primary partition.**

mounted volume A volume whose data is available to the server for use. An icon appears on the desktop for each mounted volume. Connecting the cables and connectors on the disk is the physical connection of a volume to the server, and mounting the volume is the logical connection of a volume. **out of sync** The condition in which data on the primary partition and data on the mirror partition of a mirrored volume may not match. When this occurs, the mirrored volume must be rebuilt.

partition A delineation of space on a disk. You partition a disk by using software that divides the disk into parts that then function as separate disks. To have multiple volumes on a disk, which is common when using Apple RAID, you need to create multiple partitions on the disk. See **volume**.

PCI Acronym for *Peripheral Component Interconnect,* a standard for personal computers that specifies a high-speed data path between the CPU and peripheral devices.

physical block A unit of measurement used by disk drivers. A physical block is typically 512 bytes. In Apple RAID, the stripe unit size is measured in physical blocks.

primary partition The partition in a mirrored volume from which data is read.

RAID Acronym for *redundant array of independent disks*.

rebuild When an Apple RAID disk that contains a mirrored volume fails, the Apple RAID Setup program reconstructs the volume to the state that it was in before the disk failed.

rebuild rate The speed at which RAID reconstructs a failed disk. A faster rebuild rate takes less time but puts more demands on the server, and hence slows down the performance of the server for clients. **stripe unit size** An adjustable setting of a striped volume. The stripe unit size determines the number of physical blocks written to a striped partition for each write operation to a striped volume. Adjusting the stripe unit size may affect the performance of a striped volume.

striping In Apple RAID, a technique that improves performance by spreading data across several disks and SCSI buses. See also **weighted striping**.

ungraceful shutdown Shutting down the server in any way other than using the Shut Down command or the Restart command. On a server containing a mirrored volume, an ungraceful shutdown can result in out-of-sync data on the mirrored volume.

unmounted volume A volume whose data has been made unavailable by using the Unmount/Mount command in the Volume menu.

volume On a hard disk, a volume is the logical unit that sits inside a partition. Each volume is represented on the desktop by an icon and may correlate to one or more disks. A primary and a mirror partition are referred to as a *mirrored volume*.

weighted striping A technique that causes proportionally more data to be stored on a disk attached to the faster of two SCSI buses.

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Apple RAID Software Administrator's Guide

For PCI-Based Workgroup Servers

É Apple Computer, Inc.

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