Array Management Guide

Adaptec Array1000 Family

PCI-to-Wide UltraSCSI Array Adapters

adaptec®

Adaptec Array1000 Family Array Management Guide
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If you have questions about installing or using your Adaptec product, check this user's guide first—you will find answers to most of your questions here. If you need further assistance, please contact us. We offer the following support and information services:

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- Adaptec World Wide Web (WWW) site at http://www.adaptec.com.
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- Adaptec USA Bulletin Board Service (BBS) at 408-945-7727; supports up to 28,800 bps (bits per second), 8 data bits, 1 stop bit, no parity. No product literature is available on the Adaptec BBS.
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- For technical support and information about many of Adaptec's electronic support services, call 800-959-7274 or 408-945-2550, 24 hours a day, 7 days a week.
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Errata

To review errata information associated with the Array1000 Family product and its documentation, view the readme files in a text editor or word processing program. You can find the readme files on the Adaptec CI/O Array Management Software compact disc and on the Array1000 Family Manager Set diskette.

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Getting Started

This document explains how to manage arrays with the software included with your Adaptec® Array1000™ Family product. It includes instructions on using all the software features and information on how to replace drives, reconstruct arrays, etc. The *Installation and Hardware Guide* for your Adaptec Array1000 Family product has instructions on how to *install* the software (including drivers) on the server and on networked clients.

The Adaptec Array1000 Family currently includes the following products:

Note: The three AAA™-13x array adapters are part of the *AAA-130 Series.*

- **AAA-131 Array Adapter**, a half-size PCI form factor board with one SCSI channel. This array adapter supports up to 15 Fast / Wide SCSI or UltraSCSI devices—both disk drives and other kinds of SCSI devices.
- **AAA-132 Array Adapter**, a full-sized PCI form factor board with two SCSI channels. This array adapter supports up to 30 Fast / Wide SCSI or UltraSCSI devices—both disk drives and other kinds of SCSI devices.
- **AAA-133 Array Adapter**, a full-sized PCI form factor board with three SCSI channels. This array adapter supports up to 45 Fast / Wide SCSI or UltraSCSI devices—both disk drives and other kinds of SCSI devices.

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- **ARO™-1130 PCI RAID*port*™ Card**, a RAID co-processor upgrade card for RAID*port*™ On-board systems and motherboards. RAID*port* On-board systems and motherboards include a RAID*port* connector and one or more Adaptec UltraSCSI ASICs on the motherboard. The ARO-1130 upgrades one, two, or three UltraSCSI channels on the motherboard to Adaptec RAID. The ARO-1130 card itself has no internal or external SCSI connectors.

Array Management Software Overview

Here is a brief description of the array management software included with your Adaptec Array1000 Family product.

- **Array*Config*™ Initial Boot Array Installation Utility** - After you install your Adaptec Array1000 Family product in a server or workstation you use the Array*Config* program to create the first array, to designate a boot array (if desired), and to create spares. Array*Config* runs from a self-booting diskette and can be used before you install NetWare or another operating system on the server. Array*Config* is documented in Part 1 (Chapter 2) of this document.
- **Adaptec CI/O™ Array Management Software (NetWare server)** You install the character-based version of Adaptec CI/O Array Management Software on servers running under NetWare. This program is used for ongoing management of the server on which it is installed: adding arrays and spares, viewing array and device information, scheduling array operations, and so on. The NetWare version of Adaptec CI/O Array Management Software is documented in Part 2 (Chapters 3 through 6) of this document.
- **Adaptec CI/O Array Management Software (Windows NT™ server)** - You install the graphical user interface (GUI) version of Adaptec CI/O Array Management Software on servers running under Windows NT. Like the NetWare version, this program is used for ongoing management of the server on which it is installed. The Windows NT version of Adaptec CI/O Array Management Software is documented in Part 3 (Chapters 7 through 12) of this document.
- **Adaptec CI/O Array Management Software (Windows® client)** - You install the Windows client version of Adaptec

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CI/O Array Management Software on networked clients running under Windows 3.11, Windows® 95, or Windows NT Workstation 3.51 or 4.0. Like the Windows NT server version, this program is used to monitor and manage server and array activities. Unlike the other versions, it gives you access to information on multiple servers to which the client is connected via the network. The Windows client version of Adaptec CI/O Array Management Software is documented together with the Windows NT server version in Part 3 (Chapters 7 through 12) of this document because the appearance and operation of these applications is nearly identical.

Using the Array Management Software

Here is some general information on using the Adaptec array management software most effectively.

- Use Array*Config* to create your first array(s) when you are configuring the server. We recommend that you use RAID 1, RAID 0/1, or RAID 5 arrays because of their data redundancy features. (RAID 0 arrays are also supported.)
- We recommend that you create a bootable array so you can boot the server from it instead of from a stand-alone disk drive. A bootable array protects your network operating system files and data files from a disk drive failure.
- Use the password feature of Adaptec CI/O Array Management Software to prevent unauthorized users from changing your array configuration.
- Use Adaptec CI/O Array Management Software to monitor the status of arrays and other devices on the server. It is especially convenient to use the Windows client version to do this, because you can receive status updates (event notifications) from multiple remote servers. You can simultaneously monitor servers running under different operating systems.
- Be sure that arrays are adequately protected with spare pools (recommended) or dedicated spares. You can create and delete spares with any of the array management software programs.
- Use Adaptec CI/O Array Management Software to set up regularly scheduled verification of fault-tolerant arrays and test-

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ing of spares. Respond immediately to arrays in *Critical* status, and replace failed spare disks promptly.

- Use Adaptec CI/O Array Management Software, running either on the server console or on a networked client, to add, delete, or reconfigure arrays after the server has already been in use. (You need special access rights in order to change the server configuration.) Or use Array*Config* to do these tasks from the server while the server is off-line.

Conventions and Advisories

This document uses the following typographic conventions:

bold
Used for key names (… press the **Enter** key …) and for options you are told to select (… select **Configure SCSI Channels**…).

Helvetica
Used for screen messages (…Save changes?…) and for text that must be typed exactly as shown.

Helvetica Italics
Used for program and file names when referenced in the text (… these changes are made to the *config.sys* file…).

This document uses two kinds of advisories:

Note: This kind of advisory presents reminders, tips, or suggestions for using the array management software.

Caution: This kind of advisory cautions you about actions that could destroy data or damage the computer system.

Use caution when handling any electrical equipment. Advisories in this document can only cover the procedures contained here, and not all situations may have been addressed. Adaptec does not claim to have included every condition or situation that might require a Caution or Warning. You must refer to the documentation for your computer and peripheral devices when you are installing equipment or changing its configuration.

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▼▼▼▼ Part 1

Using the Array*Config* Initial Boot Array Installation Utility

2

Using the Array*Config* Initial Boot Array Installation Utility

This chapter explains how to use the Array*Config* Initial Boot Array Installation Utility to create and delete arrays and spare disks. You can use Array*Config* to create a bootable array for the server. We recommend that you configure the server to boot from an array instead of from a single disk. This provides greater protection for network operating system files and data files stored on the array.

Array*Config* runs from a diskette, so you can run it when the server is off-line and the operating system is not running. Nearly all Array*Config* functions except creating a bootable array can also be performed with Adaptec CI/O Array Management Software, which runs under Windows and NetWare.

See the *Installation and Hardware Guide* for your Adaptec Array1000 Family product for information on connecting SCSI devices, installing software, preparing to run Array*Config*, and creating your first array with Array*Config*.

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Creating an Array with Array*Config*

You can create arrays with Array*Config* or with Adaptec CI/O Array Management Software, which is described in Parts 2 and 3 of this document. However, if you want to install the operating system on the array, you must create the array with Array*Config*. The following instructions can be used to create a bootable or a non-bootable array.

Note: To select Array*Config* menu options, type the *hot key*—the letter that appears in a different color. (The hot key letters are underlined in the following instructions). You can also press the ↑ and ↓ keys until the option is highlighted and then press **Enter**. If you have a monochrome monitor and the highlight bar is not visible, press **Ctrl-B** to change to monochrome mode.

1. Insert the copy of the Array*Config* diskette in drive *A* of the server with the Adaptec Array1000 Family product and boot the server. The program will start automatically.
2. Select **Disk Array Operations** from the Main Menu.
3. Select **Create New Array** from the Disk Array Operations menu.
4. Type an array name and press **Enter**. The name can be up to 15 characters long and can include spaces and any other printable characters.
5. Select an array type from the list. Your options are
   - **RAID 0**: Data is striped across the disks in a RAID 0 array, allowing for faster I/O performance than a single disk. RAID 0 arrays do not store redundant data; if any disk in the array fails, all data is lost.
   - **RAID 1**: Data is mirrored on one pair of disks. If one disk fails, data is still safe. The actual usable data capacity of the array equals half the available disk space.
   - **RAID 5**: The array contains redundant (parity) data distributed across all disks in the array. If any one disk fails, data can be reconstructed from the parity information. If a second disk fails before the array has been reconstructed, all data is lost. The actual usable data capacity of the array

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is equal to one less than the total number of disks. (One disk's worth of capacity is needed to hold the parity information.)

– **RAID 0/1**: Data is striped and mirrored on two or more pairs of disks. If one disk in a pair fails, data is still safe. The actual usable data capacity of the array equals half the total available disk space.

See Appendix B, *Understanding Arrays and RAID Technology*, for more information on RAID levels and RAID technology.

6 Type the number of drives you want in the array and press **Enter**. This number should not include *spares* (drives that will automatically replace failed array drives). The number of drives available for assignment is listed on the screen.

Note: This step does not apply to RAID 1 arrays, which have two drives by definition.

7 When the next screen appears, press **Tab** to highlight a channel (if your Adaptec Array1000 Family product has more than one channel). When the drives on the highlighted channel appear in the SCSI IDs on Channel menu, select drives for the array. To do this, press the ↑ and ↓ keys until the drive name is highlighted, and then press **Ins** or **Enter**. The names of selected drives appear to the right, in the Adaptec Array # box.

To select drives on a different channel (if necessary) press **Tab** to select another channel and then select the drives from the SCSI IDs on Channel menu. To deselect the drive you most recently added, press **Del**.

Caution: A warning appears if you select a disk that has partitions. *Do not* select disks with partitions if they contain data you want to keep, because any existing data will be erased when the disk becomes part of the array.

When you have selected the number of drives you specified in Step 6, the next screen appears automatically. If you are creating a RAID 1, RAID 0/1, or RAID 5 array, and if there are any

unassigned drives, the screen prompts you to define dedicated spare drives for the array. (We recommend that you use a *spare pool* instead of dedicated spares. See *Adding a Disk to a Spare Pool* on page 2-9 for more information.)

Note: A spare must have at least the capacity of the smallest drive in the array.

8 If you do not want a spare, type n and continue with Step 10. If you want to select dedicated spares, follow these steps:

a At the prompt, type y.

b At the next prompt, type 1 or 2.

c Select one or two spares, using the same method you used to select disks for the array.

9 When the Initialize Mode menu appears, select **Initialize Array to Zero**. Formatting begins immediately. A graph on the screen shows the progress of this operation.

Caution: If the drives contain data, all the data is lost when you initialize the array.

Select **Low-Level Format** only if the drives were previously formatted on another system or if you think they may have surface defects. Low-level formatting takes a long time for large disk drives. (See *Initializing an Array* on page 2-7 for more information.)

Note: If your disk drives initialize very slowly when you create arrays, you may be able to speed them up by changing a setting in the *arconfig.ini* file (located on the Array*Config* diskette). To do this, open *arconfig.ini* in a text editor and find this line: rem WriteSame=Yes. Delete the letters rem and save the file in text-only format. The next time you run Array*Config* the disks should initialize faster.

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10 When the menu of block sizes appears, select a block size. (This menu does not appear if the array is a mirrored array with only two drives.)

The allowable block sizes are 8, 16, 32, 64 (the default), and 128 KBytes. The default block size gives the best overall performance in most network server environments.

11 When you see the message Initialization of [*array name*] is complete, press any key to return to the Disk Array Operations menu.

12 To create additional arrays (if disks are available), repeat Steps 3-10. When all arrays are created, exit from Array*Config*, remove the Array*Config* diskette, and reboot the computer. After you reboot you can write data to the arrays.

Making the Array Bootable

Follow these steps if you want the server to boot from the newly created array or if you want to change the boot order of existing arrays:

1 Select **Display Boot Order** from the Main Menu. The Boot Order for Singles and Arrays window appears.

2 If the newly created array is at the top of the list, preceded by the words Unit 0, no changes are necessary; if it has some other unit number, highlight the array name and press **Enter** to select it.

3 Use the arrow keys to move the selected array to the top of the list. Then press **Enter** to de-select it. If you want to change the boot order of another array, select it, move it with the arrow keys, and press **Enter** again.

4 When you are finished, press **Esc** to return to the Main Menu.

Note: You cannot use this procedure to change the boot order of a SCSI disk drive that is not part of an array. If you want to do this, create a one-disk RAID 0 array from the disk. (Data is not actually striped on a one-disk array.)

For more important information on creating a bootable array, see the *Installation and Hardware Guide* for your Adaptec Array1000 Family product.

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Other Array*Config* Options

The remainder of this chapter explains how to use the other Array*Config* options. You can also create and manage arrays with the Adaptec CI/O Array Management Software, which is described in Sections 2 and 3 of this document.

Displaying Array Information

Follow these steps to display information about existing arrays on the server or workstation:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Display Arrays** from the Disk Array Operations menu.
3. When the list of arrays appears, highlight the array for which you want information and press **Enter**.
4. View the information that appears on the screen. This includes array type and status, array size, and information about each disk in the array.
5. Press any key to return to the Disk Array Operations menu.

Deleting an Array

Caution: All data is lost when you delete an array! Before you delete an array, back up any data you want to keep.

Follow these steps to delete an array:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Delete Array** from the Disk Array Operations menu.
3. When the list of arrays appears, select the array you want to delete.

Caution: A warning appears if you select an array that has partitions. *Do not* delete an array with partitions if it contains data you want to keep, because any existing data will be erased. Be especially careful not to select your boot array!

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4. View information about the array and make sure you really want to delete it. Press any key to continue.
5. Type y to delete the array (or n to cancel the operation).
6. When the message [Array name] deleted appears, press any key to continue.

The drives that were formerly part of the array can now be used as stand-alone drives or as members of another array. Deleting an array may change the boot order and the drive assignment.

Initializing an Array

When you create a new array, you are automatically prompted to initialize (format) it. You can also select the Format / Initialize Array option as a separate command, perhaps to reinitialize an array that has become corrupted.

Here is more information on the two initialization methods:

- **Initialize Array to Zero:** (Recommended method) Fills the array with zeroes. This option is faster than a low-level format, but it does not verify the integrity of the disks.
- **Low-level Format**: Performs a low-level SCSI format. This writes a consistent pattern to the disks, checks the disks for defects, and fills the array with zeroes. Low-level formatting can take a long time if the disks are large.

Caution: Formatting or initializing an array erases all data on the array and cannot be aborted once it has started. If the array contains data you want to keep, be sure to back it up first!

Follow these steps to initialize an array:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Format/Initialize Array** from the Disk Array Operations menu.
3. When the list of arrays appears, select the array you want to initialize.
4. Type y to confirm that you want to format the array.

Caution: A warning appears if you select an array that has partitions. *Do not* initialize an array with partitions if it contains data you want to keep, because any existing data will be erased. Be especially careful not to initialize your boot array!

5. When the Select Format Mode menu appears, select **Initialize Array to Zero** or **Low-Level Format**.
6. When the list of block sizes appears, select a block size. The allowable block sizes are 8, 16, 32, 64 (the default), or 128 KBytes. (This menu does not appear if the array is a mirrored array with only two drives.) The default block size provides the best overall performance for most applications. Formatting begins immediately.
7. When you see the message Initialization of [*array name*] is complete, press any key to return to the Disk Array Operations menu.

Creating and Deleting Spares

Spare disks (*spares*) are an important data protection and real-time recovery feature of RAID 1, RAID 0/1, and RAID 5 arrays. (RAID 0 arrays do not support spares.) If a disk in an array fails while the server is running, a spare is activated immediately to take its place. The array software automatically reconstructs the necessary data on the new disk, and array operation continues uninterrupted.

You can create one or two *dedicated spares*, which can be used only by a single specified array. We recommend, however, that you create a *spare pool* instead. The spares in a spare pool can be used as needed by *any* array connected to the same controller, if the spare is at least as large as the smallest disk in the array. A spare pool can have up to eight disks.

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Adding a Disk to a Spare Pool

Follow these steps to create a new spare pool or to add a disk to an existing spare pool. You should add a disk to the spare pool whenever one of these spares is automatically used to replace a failed array member.

1. Select **Spare Pool Operations** from the Array*Config* Main Menu.
2. Select **Add Device to Spare Pool** from the Spare Pool menu.
3. Select a channel from the list, if necessary.
4. Highlight a disk to add to the spare pool and press **Enter**.

Caution: A warning appears if you select a disk that has partitions. *Do not* select disks with partitions if they contain data you want to keep, because any existing data will be erased when the disk is added to the spare pool. Be especially careful not to select your boot disk as a spare!

The spare is added immediately. Press any key to return to the Spare Pool Operations menu.

5. Repeat Steps 2-4 to add another disk to the spare pool. Spare pool disks can be connected to any channel on the adapter.

Note: You can add a disk of any size to the spare pool, even if the disk is too small to protect the existing arrays. For example, if you have created two arrays with 1 GByte members, you can add a 500-MByte disk to the spare pool, even though this disk is too small to replace any failed array member. If you later create a third array with 500-MByte members, the smaller spare pool disk can automatically replace a failed member of that array.

6. When you have finished adding disks, press **Esc** to return to the Array*Config* Main Menu.

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Deleting a Disk from a Spare Pool

Follow these steps to delete a disk from a spare pool:

1. Select **Spare Pool Operations** from the Array*Config* Main Menu.
2. Select **Delete Device from Spare Pool** from the Spare Pool menu. The disk most recently added to the spare pool is immediately deleted. Press any key to return to the Spare Pool menu.
3. Repeat Step 2 to delete another disk from the spare pool, if desired.
4. When you have finished deleting disks, press **Esc** to return to the Array*Config* Main Menu.

Viewing Spare Pool Information

Follow these steps to view information about disks in a spare pool:

1. Select **Spare Pool Operations** from the Array*Config* Main Menu.
2. Select **Display Spare Pool Devices** from the Spare Pool menu.
3. View the spare pool information that appears on the screen. When you are finished, press any key to return to the Spare Pool menu.

Adding a Dedicated Spare

When you create an array you have the option of adding one or two dedicated spares to it. You can also add dedicated spares to an existing array at a later time.

Note: We recommend that you create a spare pool instead of using dedicated spares. See *Creating and Deleting Spares* on page 2-8 for more information.

You *cannot* add dedicated spares to an array if

- The array already has two dedicated spares
- The remaining single disks are not at least as large as the smallest disk in the selected array

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Follow these steps to add one or two dedicated spares to an array:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Add/Delete Spare Drive** from the Disk Array Operations menu.
3. Select the array to which you want to add the dedicated spare.
4. Select **Add Spare Drive** from the Add/Delete Spare menu.
5. Select a SCSI channel on the left, if necessary, and then press → to move to the list of disks on the right. Disks are grayed out if they are already used in an array or if they are smaller than the members of the array. Highlight an available disk and press **Enter**. Then select another disk for the second spare, if necessary. The new dedicated spare is added immediately.

Caution: A warning appears if you select a disk that has partitions. *Do not* select disks with partitions if they contain data you want to keep; any existing data will be erased when the disk becomes a spare. Be especially careful not to select your boot disk as a spare!

6. Press any key to continue.

Deleting a Dedicated Spare

Follow these steps to delete a dedicated spare:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Add/Delete Spare Drive** from the Disk Array Operations menu.
3. When the list of spare drives appears, select the one you want to delete and press **Enter**.
4. Select **Delete Spare Drive** from the Add/Delete Spare Drive menu. The dedicated spare is deleted immediately.
5. Press any key to continue. The disk that was formerly a dedicated spare can now be used as a spare for another array or as a member of another array.

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▼▼▼▼ Part 2

Using Adaptec CI/O Array Management Software for NetWare

3

Configuring Arrays and Spares

This chapter explains how to use the menu-driven NetWare version of Adaptec CI/O Array Management Software to configure arrays and spares on your NetWare server. (See the *Installation and Hardware Guide* for your Adaptec Array1000 Family product for instructions on installing Adaptec CI/O Array Management Software.) You can also configure arrays and spares with the Array*Config* utility, as described in Chapter 2, or from a networked client, as described in Chapter 8.

When you are running the NetWare version of Adaptec CI/O Array Management Software you can press **F1** on most screens to view on-screen Help information.

Starting and Exiting the Program

Your server console may already be configured to start Adaptec CI/O Array Management Software automatically when you boot the server. Follow these steps if the program does not start automatically:

1. Start the server, if it is not already running.
2. Mount the *sys* volume, if it is not already mounted.
3. At the NetWare prompt, enter the command load cioams.nlm.

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Note: The Adaptec CI/O Array Management Software NLM may load automatically when you start NetWare, depending on the options you chose when you installed it.

4 When the Main Menu appears, as shown in Figure 3-1, you are ready to use Adaptec CI/O Array Management Software.

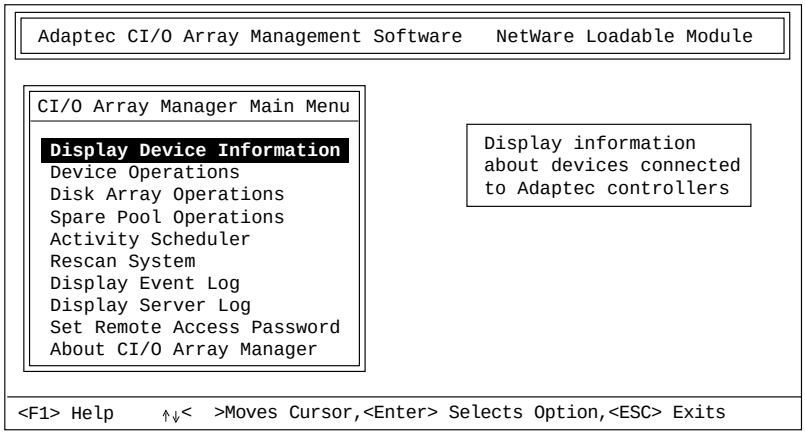

Figure 3-1. CI/O Array Management Software Main Menu

5 To exit Adaptec CI/O Array Management Software, return to the Main Menu and press **Esc**.

6 Type y in response to the prompt to confirm that you want to exit. Then reboot the server if necessary. (You must reboot before you can write data to newly-created arrays.)

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Creating an Array

Follow these steps to create a new array on your NetWare server:

1. Select **Disk Array Operations** from the Main Menu.
2. When the Array Operations menu appears, select **Create a New Array**. The Select Drives to Create Array window appears, similar to Figure 3-2.

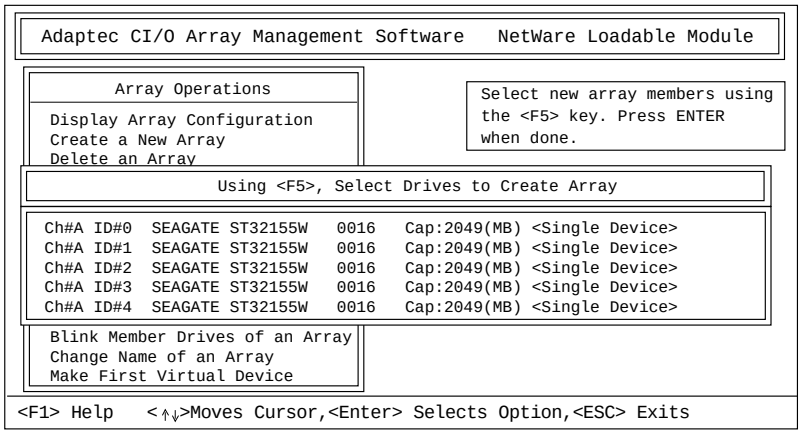

Figure 3-2. Select Drives to Create Array Window

Note: An error message appears if no disks are available to create the array.

The window lists all the disks that are available to create the new array.

3. Highlight each disk you want to include as a member of the array (not as a spare) and press **F5** to mark it. The disks can be on different SCSI channels of the same Adaptec Array1000 Family product.

Caution: When a disk becomes an array member, any data that was on the disk is lost. Be sure to back up any data on the disk that you want to keep.

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The following table shows the maximum and minimum number of array members and spares allowed for each type of array (see Appendix B, *Understanding Arrays and RAID Technology*, for more information on RAID technology):

RAID Level	Minimum Disks	Maximum Disks[1]	Dedicated Spares	Pool Spares
RAID 0 (Striped)	1[2]	16	None	None
RAID 1 (Mirrored)	2	2	1 or 2	up to 8
RAID 0/1 (Mirrored & Striped)[3]	4	16	1 or 2	up to 8
RAID 5 (Striped, with Distributed Parity)	3	16	1 or 2	up to 8

[1] This is the maximum number of disks supported by the software driver. The maximum for your computer system may be less, depending on how many SCSI channels and devices you have.

[2] The purpose of one-disk RAID 0 arrays is to give you more control over the virtual device order of disks controlled by the Adaptec Array1000 Family product. This is also useful for defining the system's boot device.

[3] RAID 0/1 arrays must have an even number of disks.

4 When all the disks needed for the array are highlighted, press **Enter**.

A warning message appears if you have selected a disk with a partition. If the partition is recognized by the operating system, you *cannot* use the disk in the array. If the partition is *not* recognized by the operating system, you *can* use the disk in the array.

You are prevented from using disks with recognized partitions for the array so you will not, for example, accidentally erase the server's boot disk or erase files currently being used by the server.

5 When the prompt appears, enter a name for the array. You can use up to 15 characters, including spaces and any other printable characters. The name is used to display the array and to identify the source of event notifications. Press **Enter** when you have typed the name.

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Note: You can change the array name later, if necessary. See *Renaming an Array* on page 5-7 for more information.

6 When the prompt appears, select a RAID level for the array. Then press **Enter**.

The available RAID levels depend on how many disks you chose for the array. For example, RAID 1 and RAID 0/1 are not available if you chose three disks, because they require an even number of disks. See *Selecting a RAID Level for an Array* on page 13-5 for information about the different RAID levels.

7 When the prompt appears, select a Stripe Size for the array. Then press **Enter**. (This menu does not appear if the array is mirrored and has only two disks.) The recommended stripe size of 64 KBytes usually provides the best overall performance for most servers.

8 (Optional) When you are prompted, select dedicated spares for the array by highlighting one or two disks and pressing **F5**.

Note: We recommend that you use a spare pool instead of dedicated spares. See *Using a Spare Pool* on page 3-12 for more information.

You can add one or two dedicated spares to RAID 1, RAID 0/1, and RAID 5 arrays. Disks already selected as array members are marked with **Reserved**. An error message appears if you try to select one of these disks as a spare. The spare(s) you select should be at least as large as the smallest array member.

9 Press **Enter** when you are finished selecting spares. An event notification may appear at this point. Press **Esc** to remove this notification. Event notifications are recorded in the Event Log. For more information, see *Viewing the Server Log* on page 4-3.

10 When prompted, select **Yes** to initialize the array.

If you prefer to initialize the array later, select **no** at this prompt. If you choose not to initialize the array now, you

should initialize it later (see *Initializing an Array* on page 3-10). RAID 1, RAID 0/1 and RAID 5 arrays *must* be initialized before you can write data to them. RAID 0 arrays can be used without being initialized. However, we recommend that you initialize them anyway to verify the media surface.

11 Read the event notifications that indicate the array has been created successfully. Then press **Esc** to continue. (Skip to Step 13 if you chose not to initialize the array.)

If a red text window appears with the message Failed to Create Array, open the Server Log and see if there is a description of the error. Reboot the server, restart Adaptec CI/O Array Management Software, and rescan the system to assure that all devices are responding (see *Rescanning the Server* on page 4-8). Then try again to create the array.

12 A message appears indicating that the initialization process has started successfully. Press **Esc** to dismiss this message. If you wish, you can press **Alt-Esc** to view a graph showing the progress of the initialization process, as shown in Figure 3-3.

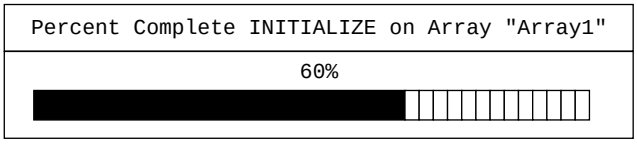

Figure 3-3. Graph of Initialization Process

Detailed information about the array appears in a window above the graph. If you want to abort the initialization (not recommended), press **F7** from the screen with the graph and select **Yes**.

You can perform other tasks in Adaptec CI/O Array Management Software while the array is being initialized, as long as they do not interfere with the initialization process. For example, you can view array information, but you cannot delete the array that is being initialized.

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13 If you want to create another array, return to Step 1 and repeat the process. When you have defined all the arrays and spares you want, exit from Adaptec CI/O Array Management Software and reboot the server so NetWare can recognize the new array(s).

After you create an array you must reboot the server and partition the array as you would partition a stand-alone disk. If you want to make the array bootable, continue with the next section, *Making an Array the First Virtual Device.*

Making an Array the First Virtual Device

You can configure the server to boot from a stand-alone disk or from an array. If you want to boot from a stand-alone SCSI disk, we recommend that you assign SCSI ID 0 to this disk and that you connect it to Channel A of the Adaptec Array1000 Family product (if it has more than one channel). We recommend that you configure the server to boot from a fault-tolerant (RAID 1, RAID 0/1, or RAID 5) array to provide better data protection and better I/O performance than a single disk.

Note: You can also use the Array*Config* program to select a boot array. See *Making the Array Bootable* on page 2-5.

You make an array bootable by assigning it virtual device order #0. The *virtual device order* is the sequence in which the server's operating system detects arrays, single disks, and other devices connected to the Adaptec Array1000 Family product when the server boots. You may also need to move the Adaptec Array1000 Family product to a different PCI slot. For more information, see the *Installation and Hardware Guide* for your Adaptec Array1000 Family product.

Follow these steps to make an array the first virtual device:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Make First Virtual Device** from the Array Operations menu. The Make First Virtual Device window appears, similar to Figure 3-4.

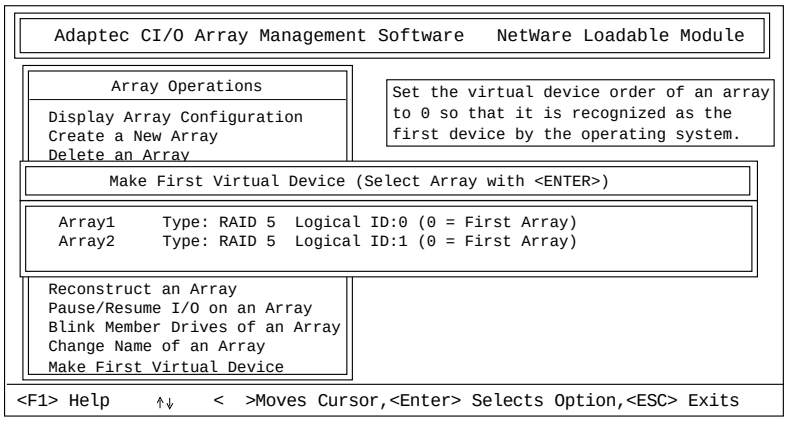

Figure 3-4. Make First Virtual Device Window

3. Highlight the array you want to select as the boot array, and press **Enter**.
4. When the message appears, select **Yes** to confirm that you want this array to be the boot array. An event notification appears.
5. Read the event notification and press **Esc** to continue. The notification should indicate that the array has been made bootable.
6. Exit Adaptec CI/O Array Management Software. If the selected array does not already have a bootable partition on it, reboot the server to a bootable floppy disk. Then install DOS and NetWare on the array and configure it as required so the server can boot from it. See the *Installation and Hardware Guide* for your Adaptec Array1000 Family product for more information, including information on installing NetWare from a CD.

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Deleting an Array

Caution: Back up the data on an array before you delete it. All data on the array disks is lost when you delete the array.

When you delete an array, all the disks that were members of the array become single, *stand-alone* disks again. You can then use them as spares or as members of a new array. If you want to delete an array that has a NetWare volume, you must dismount the volume first.

Follow these steps to delete an array:

1. Select **Disk Array Operations** from the Main Menu.
2. When the Array Operations menu appears, select **Delete an Array**. The Delete Array window appears, similar to Figure 3-5.

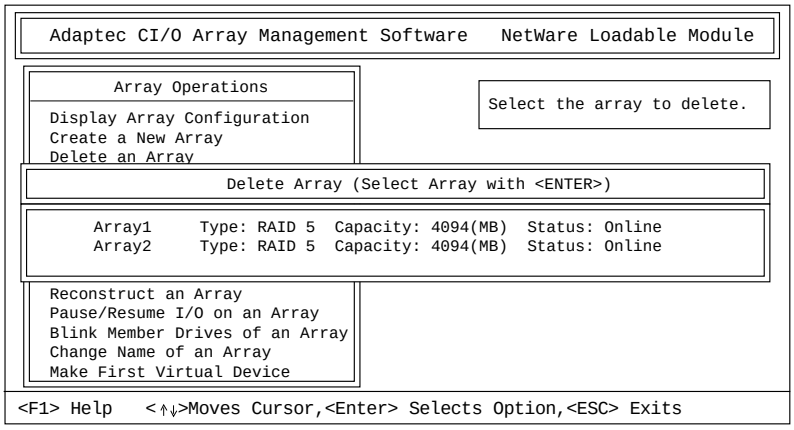

Figure 3-5. Delete Array Window

3. Highlight the array you want to delete, and press **Enter**.

   A warning message appears if the selected array has a partition. If the partition is recognized by the operating system, you *cannot* delete the array. You are prevented from deleting an array with recognized partitions so you will not accidentally erase the server's boot array or lose important information. If you still want to delete the array, dismount the NetWare

volume of the array, and delete its partition with NetWare tools. Then you can delete the array with Adaptec CI/O Array Management Software.

4 When the message appears, select **Yes** to confirm that you want to delete this array.

5 Read the event notifications that appear on the screen and press **Esc** to continue.

Note: After you delete an array you can immediately use the disks that formerly belonged to the array to create spares or a new array without rebooting the server. However, you must reboot the server before you can use the disks as single disks that are not members of an array. Deleting an array may change the boot order and the drive assignment.

Initializing an Array

When you create a new array you are automatically prompted to initialize it, as described on page 3-5. If you wish, you can skip that step and initialize the array later by following the instructions in this section. You can also reinitialize an array that has already been in use. For example, you may wish to delete data that was written to the array by a system test sequence.

You can also perform a low-level SCSI format on the array with Array*Config*, as explained in *Initializing an Array* on page 2-7.

Caution: Back up the data on an array before you reinitialize it. All data on the array disks is lost when you initialize the array.

Follow these steps to initialize an array to which data has previously been written or a new array that has been defined but not initialized:

1 Select **Disk Array Operations** from the Main Menu.

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2 When the Array Operations menu appears, select **Initialize an Array**. The Initialize an Array window appears, similar to Figure 3-6.

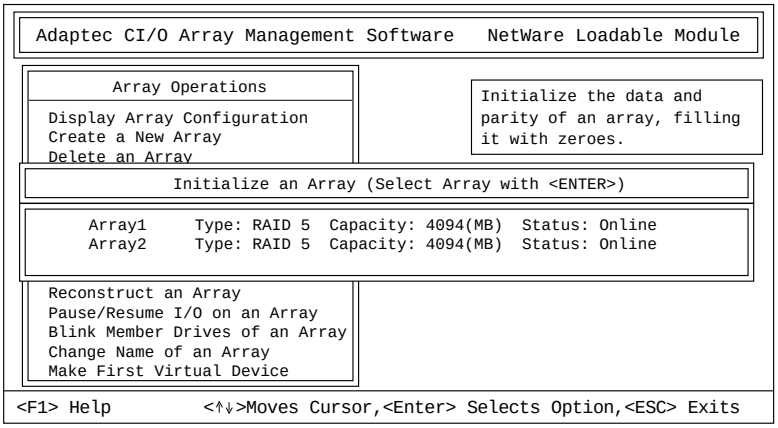

Figure 3-6. Initialize an Array Window

3 Highlight the array you want to initialize and press **Enter**.

A warning message appears if you have selected a disk with a partition. If the partition is recognized by the operating system, you *cannot* initialize the array. If the partition is *not* recognized by the operating system, you *can* initialize the array.

You are prevented from initializing an array with recognized partitions so you will not accidentally erase the server's boot array.

4 Select **Yes** to confirm that you want to initialize the array.

5 A message appears indicating that the initialization process has started successfully. Press **Esc** to dismiss this message. If you wish, you can press **Alt-Esc** to view a graph showing the progress of the initialization process, as shown in Figure 3-3 on page 3-6.

You can perform other tasks in Adaptec CI/O Array Management Software while the array is being initialized, as long as they do not interfere with the initialization process. For example, you can view information for another array, but you cannot delete the array that is being initialized.

6 Press **Alt-Esc** to return to the other screen. If you want to abort the initialization (not recommended), select **Activity Scheduler** from the Main Menu, and select **Abort a Running Activity** from the Activity Scheduler menu. Then highlight the **Initialize** activity on the list that appears and press **Enter**. An event notification appears to confirm the action.

7 When the initialization process is complete, exit Adaptec CI/O Array Management Software and reboot the server.

Creating and Deleting Spares

Spare disks (*spares*) are an important data protection feature of fault-tolerant arrays. If a disk in an array fails while the server is running, a spare is activated immediately to take its place. The array software automatically reconstructs the data on the new disk, and array operation continues uninterrupted.

Note: When you install Adaptec CI/O Array Management Software it is automatically configured to test all spares on the server once a day to assure they are always available, if needed, to replace failed disks in arrays. We recommend that you leave this default setting so that all spares will be tested regularly.

Using a Spare Pool

We recommend that you create a *spare pool* instead of creating dedicated spares. The spares in a spare pool can be used as needed by *any* array connected to the same Adaptec Array1000 Family product, provided that the spare is at least as large as the smallest disk in the array. You can create a spare pool before any arrays are defined.

A spare pool is preferable to dedicated spares assigned to each array. For example, if three arrays are connected to your Adaptec Array1000 Family product, you can create a spare pool of two disks to give adequate protection for all the arrays. If one of the spare pool disks is used to replace a bad disk, you can immediately add another spare to the pool to protect the three arrays. But if you used dedicated spares, you would need at least three spares to protect the arrays.

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Note: You can add a disk of any size to the spare pool, even if the disk is too small to protect the existing arrays. For example, if you have created two arrays with 1 GByte disks, you can add a 500-MByte disk to the spare pool, even though this disk is too small to replace any failed array member. The spare pool feature is designed like this to give you additional flexibility. For example, you may be planning to create a third array later with 500-MByte disks.

Adding a Disk to the Spare Pool

Follow these steps to create a new spare pool or to add a disk to an existing spare pool:

1. Select **Spare Pool Operations** from the Main Menu.
2. Select **Create a Pool Spare** from the Spare Pool Operations menu. A screen similar to Figure 3-7 appears.

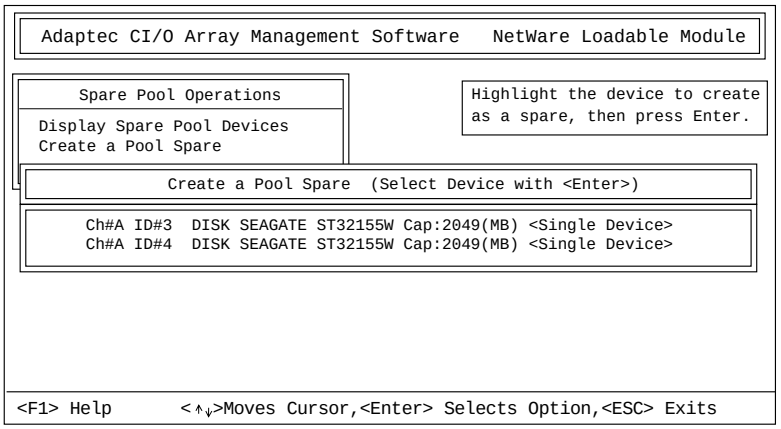

Figure 3-7. Create a Pool Spare Window

The window located in the center of the screen lists the single disks that are available for pool spares.

3. Highlight a disk on the list and press **Enter**.

   A warning message appears if you have selected a disk with a partition. If the partition is recognized by the operating system, you *cannot* use the disk as a spare. If the partition is *not*

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recognized by the operating system, you *can* use the disk as a spare.

You are prevented from using disks with recognized partitions as spares so you will not accidentally erase the server's boot disk or delete important information.

4 Select **Yes** to confirm your choice.

5 Read the event notifications that appear on the screen and press **Esc** to dismiss them.

6 Repeat Steps 2-5, if necessary, to add more disks to the spare pool.

Deleting a Disk from the Spare Pool

Follow these steps to delete a disk from a spare pool. Once it is deleted, the disk is available to use as a member of another array or as a dedicated spare:

1 Select **Spare Pool Operations** from the Main Menu.

2 Select **Delete a Pool Spare** from the Spare Pool Operations menu. A screen similar to Figure 3-8 appears.

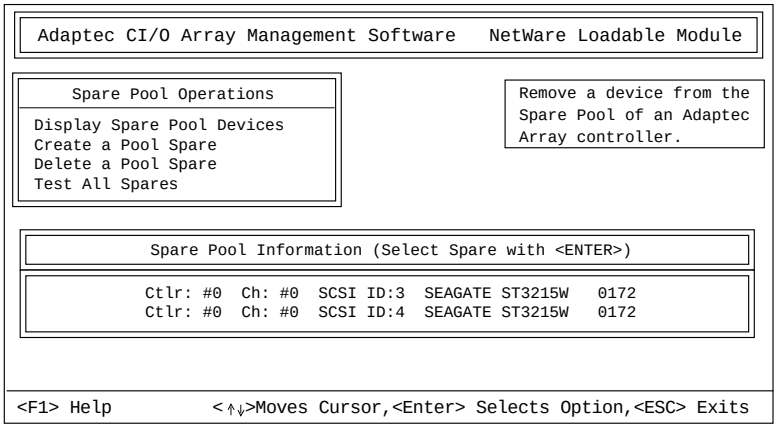

Figure 3-8. Delete a Pool Spare Window

The window located in the center of the screen lists the disks in the spare pool.

3 Highlight a disk on the list and press **Enter**.

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4 Select **Yes** to confirm your choice.

5 Read the event notifications that appear on the screen and press **Esc** to dismiss them.

6 Repeat Steps 2-5, if necessary, to delete other disks from the spare pool.

Viewing Spare Pool Information

Follow these steps to view information about the disks in a spare pool:

1 Select **Spare Pool Operations** from the Main Menu.

2 Select **Display Spare Pool Drives** from the Spare Pool Operations menu. A screen similar to Figure 3-9 appears.

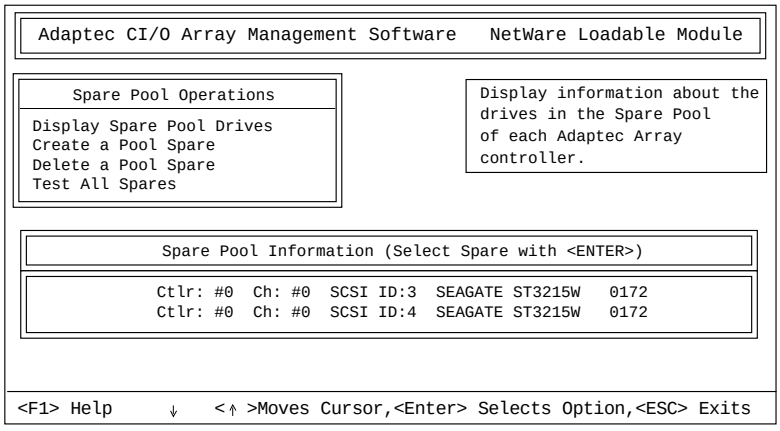

Figure 3-9. Spare Pool Information Screen

The window located in the center of the screen lists the disks in the spare pool.

3 Press **Enter** to display detailed information about the selected spare pool device. Press **Esc** when you are finished.

Adding a Dedicated Spare

Follow these steps to add a dedicated spare to an existing RAID 1, RAID 0/1, or RAID 5 array. Each array can have a maximum of two dedicated spares.

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Create a Dedicated Spare** from the Array Operations menu. A list of arrays appears.
3. Highlight the array to which you want to add a dedicated spare and press **Enter**. A list of available disks appears.
4. Highlight the disk you want to use as a spare and press **Enter**. Spares must have at least as much capacity as the smallest array member.
5. Select **Yes** to confirm that you want to add the dedicated spare.

   A warning message appears if you have selected a disk with a partition. If the partition is recognized by the operating system, you *cannot* use the disk as a spare. If the partition is *not* recognized by the operating system (for example, if the disk was previously partitioned under another operating system), you *can* use the disk as a spare.

   You are prevented from using disks with recognized partitions as spares so you will not accidentally erase the server's boot disk.
6. Read the event notifications that appear on the screen and press **Esc** to dismiss them.
7. Repeat this process, if necessary, to add a second dedicated spare to the array.

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Deleting a Dedicated Spare

Follow these steps to delete a dedicated spare from an existing RAID 1, RAID 0/1, or RAID 5 array.

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Delete a Dedicated Spare** from the Array Operations menu. A list of arrays appears.
3. Highlight the array whose dedicated spare(s) you want to delete and press **Enter**. A list of array members and dedicated spares appears.
4. Highlight the dedicated spare you want to delete and press **Enter**.
5. Select **Yes** to confirm that you want to delete the dedicated spare.
6. Read the event notifications that appear on the screen and press **Esc** to dismiss them.
7. Repeat this process, if necessary, to delete another dedicated spare from the array.

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4

Viewing Server, Array, and Device Information

Adaptec CI/O Array Management Software for the NetWare console allows you to view information about arrays, SCSI devices, and server events.

Viewing the Event Log

The Event Log is a list of recent event notifications generated by the Adaptec CI/O Array Management Software. The screen is refreshed every time a new event is received. Only ten lines of the most recent event notifications are displayed. (Some notifications take two lines.) There is no scrolling capability. Whenever you exit the program and restart it the Event Log listings start over again.

If you want to view more complete information about server events, open the Server Log, as described in *Viewing the Server Log* on page 4-3.

Event notification messages also pop up on the screen when new events are added to the log. Press **Esc** to remove these popup messages.

Follow these steps to view the Event Log:

1 Select **Display Event Log** from the Main Menu. The Event Log appears, similar to Figure 4-1.

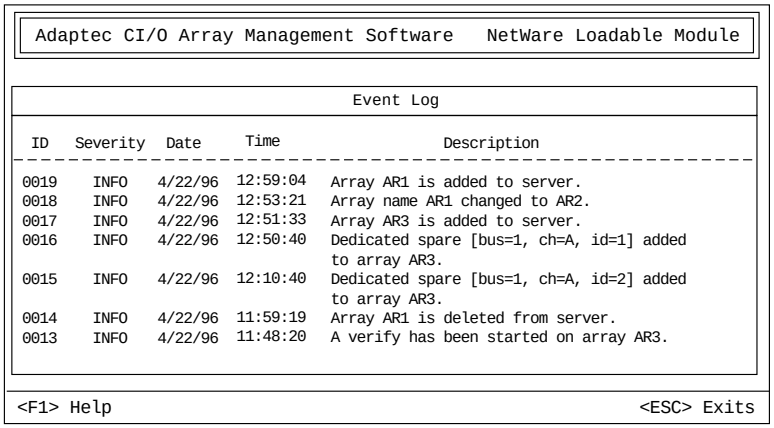

Figure 4-1. Event Log

2 View the Event Log entries.

The newest entries appear at the beginning of the list. Each entry has an ID number and the time and date at which the entry was generated. The Severity column indicates the *severity level* of the event, as follows:

- **Critical** event messages indicate problems that require the user's immediate attention, such as an array with a down drive or an off-line array.
- **Warning** event messages indicate problems that are not serious enough to cause a failure but which may require the user's attention. An example is a message indicating that the last spare has been used.
- **Informational** event messages are generated for routine events such as adding a new array, verifying an array, or changing an array name.

3 When you are done viewing the Event Log, press **Esc** to return to the Main Menu.

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Viewing the Server Log

The Server Log file, which is maintained on the server, lists all events generated by the server since it was brought online. Some examples of events are the creation of a new array, the successful completion of an array initialization, and a failed disk in an array. When you open the Server Log you can scroll backwards to view all the entries in the log. You can also clear all the log entries, which you should do periodically to keep the log from getting too large.

Note: You can keep the Server Log file from getting too large by specifying a maximum size for it in the initialization file. For more information, see Appendix A, *Configuration Settings*.

Follow these steps to view the Server Log:

1. Select **Display Server Log** from the Main Menu. The Server Log appears, similar to Figure 4-2.

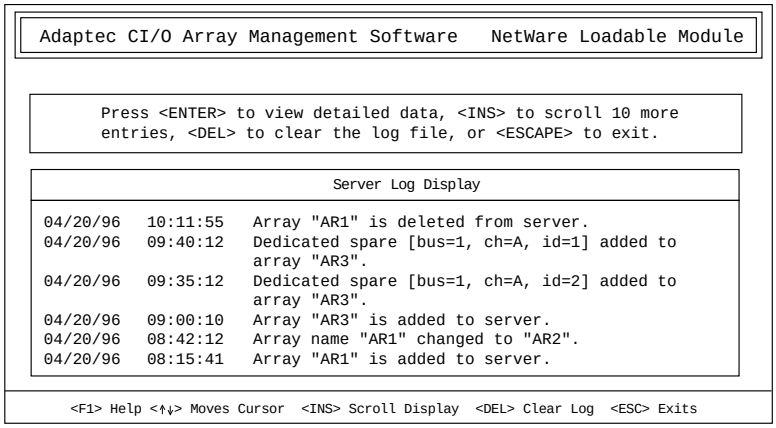

Figure 4-2. Server Log

2. View the log entries. The most recent entries are listed first. Each entry lists the time and date when it was generated and some descriptive text.
   - To view more entries, press **Ins** and then press **Pg Up** or **Pg Dn** to scroll up or down in the log.

– To view detailed information about any entry, highlight it and press **Enter**. (See the previous section for information about severity levels.) Press **Esc** to remove the window with the detailed information.

– To clear all log entries, press **Del**.

3 When you are done viewing the Server Log, press **Esc** to return to the Main Menu.

Viewing Array Information

Follow these steps to view information about arrays on the server:

1 Select **Disk Array Operations** from the Main Menu.

2 Select **Display Array Configuration** from the Array Operations menu. A screen similar to Figure 4-3 appears.

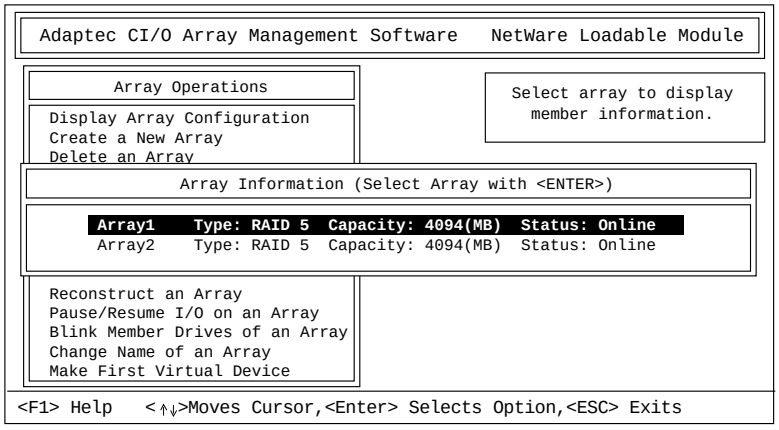

Figure 4-3. Array Information

3 Select an array and press **Enter**. Read the array information listed in the window. This includes array name, RAID level, total data storage capacity, status, stripe size, etc.

Fault Tolerant is the status that indicates RAID 1, RAID 0/1, and RAID 5 arrays are operating correctly; for RAID 0 arrays it is *Normal*.

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A Critical status may indicate that an array disk has failed, or that a failed disk is being rebuilt. See *Responding to a Critical Array* on page 13-1 for more information.

An OffLine status indicates that the array was just created and you have not rebooted the server yet, or that the array is in danger of losing data, or that array data has already been lost. See *Responding to an Off-line Array* on page 13-3 for more information.

4 Press **Enter** again. The Array Members Information window appears.

5 Read the additional information, which includes the disk status (*OKAY* is the normal status), and controller / channel / SCSI ID information.

6 To view detailed information on a single array member or spare, including manufacturer and storage capacity, highlight the entry and press **Enter**. An additional window of detailed information appears.

7 When you have finished viewing this information, press **Esc** until you return to the Main Menu.

Viewing Spare Information

- To view information on *dedicated spares*, follow the instructions in the previous section, *Viewing Array Information*. When you get to Step 6, highlight the dedicated spare and press **Enter**.
- To view information about spares in a *spare pool*, follow the directions in *Viewing Spare Pool Information* on page 3-15.

Viewing Controller and Channel Information

Follow these steps to view information about Adaptec Array1000 Family products and channels on the server:

1. Select **Display Device Information** from the Main Menu. A screen similar to Figure 4-4 appears.

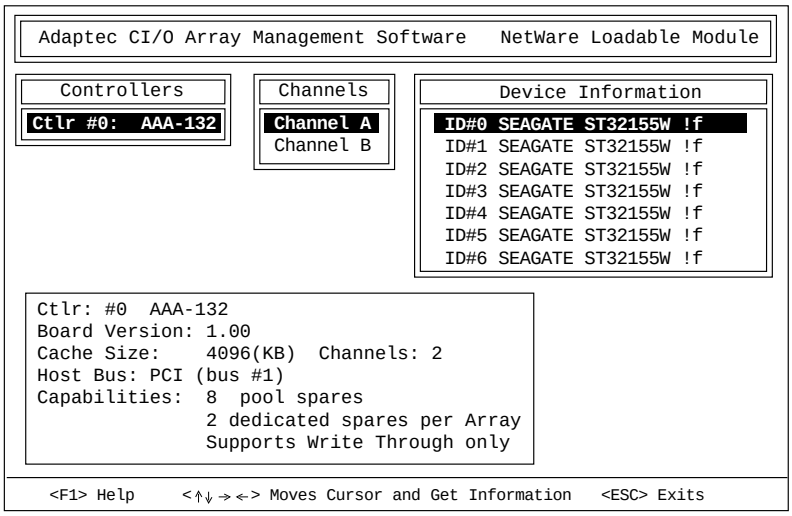

Figure 4-4. Controller and Channel Information

2. Use the ↑ and ↓ keys to highlight the Adaptec Array1000 Family product you want in the window on the left. Then read the information that appears in the window below it.
3. Press the → key to move to the Channels window, and highlight the device you want (if there is more than one channel). Then read the channel information that appears in the window below it.
4. Press the → key to move to the Device Information window, and highlight the device you want. Then read the device information that appears in the information window.
5. When you have finished viewing information, press **Esc** to return to the Main Menu.

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Viewing SCSI Device Information

In addition to viewing information about array members, you can also view information about individual SCSI devices installed in the server, including CD-ROM drives, scanners, and other non-disk devices. Some of these SCSI devices may be array members, but when you use this command you only see information about each individual device. There are two ways to do this:

- Follow the instructions in *Viewing Controller and Channel Information* on page 4-6. When you reach Step 4 you can view information for all the SCSI devices on the channel.
- Follow the numbered instructions below.

1. Select **Device Operations** from the Main Menu.
2. Select **Display Device Information** from the Select Device Operation menu. A screen similar to Figure 4-5 appears.

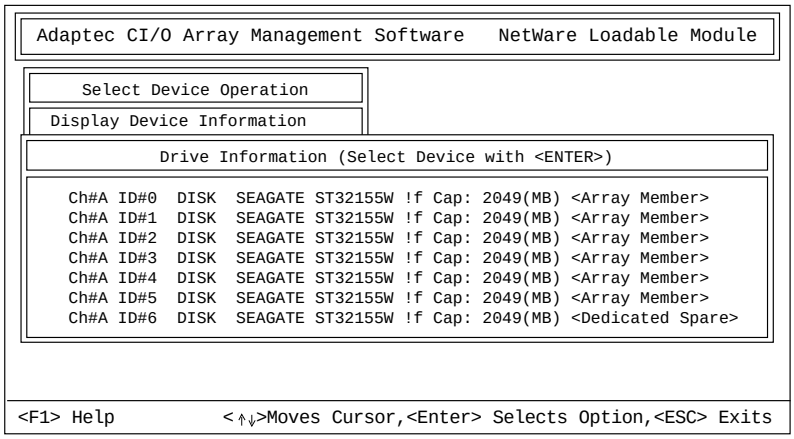

Figure 4-5. Drive Information

3. Read the device information in the window.
4. To view additional information, highlight a device in the window and press **Enter**.
5. Read the additional SCSI device information, then press **Esc** repeatedly until you return to the Main Menu.

Rescanning the Server

Whenever you boot the server the operating system software scans the server to find all installed hardware devices such as Adaptec Array1000 Family products, arrays, and SCSI devices.

If you are using an array enclosure and you make a hardware change while the server is running—for example, adding a new disk—you must use the Rescan command to allow Adaptec CI/O Array Management Software to detect the new device. A rescan is done automatically if you pause I/O on a channel and then resume I/O. You can pause I/O to a channel, insert a new disk in a currently unoccupied slot and assign it a new SCSI ID. When you resume I/O a rescan is done automatically, and Adaptec CI/O Array Management Software sees the disk as a single (stand-alone) disk. (The operating system does not detect the disk until you reboot the server, however.)

Follow these steps to rescan the system:

1. Select **Rescan System** from the Main Menu.
2. Select **Yes** to confirm that you want to rescan the system. A message appears on the screen while the rescan is taking place.
3. Wait until the System rescan complete message appears.
4. Press **Esc** to clear the message.

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5

Performing Array, Device, and Password Operations

Performing Array Operations

Reconstructing an Array

If a member of a fault-tolerant (RAID 1, RAID 0/1, RAID 5) array fails, the array status changes to *Critical*. If a spare disk is available, it is automatically activated, and the data on the failed disk is recreated on the spare. If no spare is available, you may need to use the Reconstruct command to restore the array to fault-tolerant status.

Follow these steps to reconstruct an array with a failed disk and no available spare:

1. Determine which array is in Critical status and which disk in the array has failed. To do this, follow the instructions in *Viewing Array Information* on page 4-4.

   It is possible that a RAID 0/1 array in Critical status may have more than one failed disk. The array can still be reconstructed as long as at least one disk of each mirrored pair is still good.

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2. If the drive enclosure does not support hot swapping[1], pause I/O to the array. (See *Pausing I/O on an Array* on page 5-3.) This is not necessary if the array enclosure supports hot swapping.
3. Replace the failed disk (or disks) with a good disk of at least the same storage capacity. Be sure that the SCSI ID of the new disk is different from the SCSI ID of other installed devices. Or, if an array disk was accidentally disconnected, reconnect it.
4. Wait for I/O to resume after the pause period, if you paused it in Step 2.
5. If you installed a new disk (or disks), make the disk into a spare by following the directions in *Creating and Deleting Spares* on page 3-12.
6. Select **Disk Array Operations** from the Main Menu.
7. Select **Reconstruct an Array** from the Array Operations menu. The Reconstruct Array window appears.
8. Highlight the Critical array and press **Enter**. A list of array members appears, similar to the one shown in Figure 5-1.

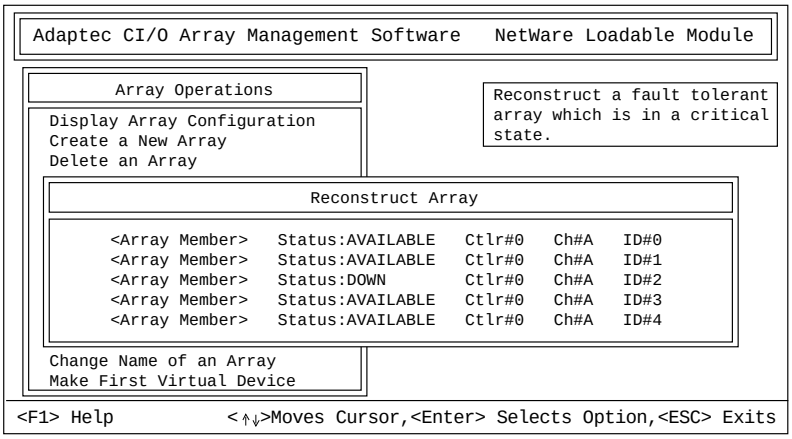

Figure 5-1. Reconstruct Array Window

[1] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad disk is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

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9. Highlight the array member whose status is *Down* and press **Enter**. (In this example, the disk at ID#2 is down; you should have already replaced the bad disk with a good disk or reconnected the disconnected disk.)
10. Select **Yes** to confirm that you want to reconstruct the array.
11. A message appears indicating that the reconstruct process has been started successfully. Press **Esc** to remove this message. If you wish, you can press **Alt-Esc** to view a graph showing the progress of the reconstruct. A window with detailed array information appears above the graph.

    You can perform other tasks in Adaptec CI/O Array Management Software while the array is being reconstructed, as long as they do not interfere with the reconstruct process. For example, you can view information for another array, but you cannot delete the array that is being reconstructed.
12. Press **Alt-Esc** to return to the other screen. Press **Esc** to remove the event notification that appears when the reconstruct is finished.
13. View the Event Log to verify that the reconstruction completed successfully. (See *Viewing the Event Log* on page 4-1.)

If you wish, you can schedule the reconstruct to occur at a later time when there will be less I/O activity on the server. See *Scheduling a New Activity* on page 6-2 for more information.

Pausing I/O on an Array

Use this option to pause data I/O on an array while you replace a disk or reconnect a loose connection in an enclosure that does not support hot swapping[2]. You may need to do this when you are restoring a Critical array to Fault-tolerant status. (See *Responding to a Critical Array* on page 13-1 for more information.) When you pause an array, all devices connected to the Adaptec Array1000 Family

[2] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad disk is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

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product are electrically paused. I/O resumes automatically after a specified pause interval.

Note: The Pause I/O command is disabled if a Verify, Reconstruct, or Initialize operation is running.

Follow these steps to pause I/O on an array:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Pause/Resume I/O on an Array** from the Array Operations menu. The Pause Array window appears with a list of arrays.
3. Highlight the array you want to pause and press **Enter**.
4. Read the message and enter a pause period that does not exceed the maximum pause period.

Note: The minimum pause period is 5 seconds; the maximum pause period is 120 seconds.

5. Press **Enter** to pause I/O, and then wait a few seconds for all data I/O to stop.
6. Do whatever you need to do to the array disks, such as reconnecting a cable or replacing a disk. Be sure you complete your work before the end of the pause period.

   A rescan is done automatically when I/O is resumed.

You can also pause data I/O to a single disk. See *Pausing I/O to a Drive* on page 5-12.

Verifying the Integrity of an Array

Use this option to verify the integrity of redundant data stored on fault-tolerant (RAID 0/1, RAID 1, RAID 5) arrays. When you run this operation, Adaptec CI/O Array Management Software checks the array for miscompares and corrects parity errors automatically. A *miscompare* occurs when the parity information on a RAID 5 array does not match the user data or when some part of the data on a mirrored disk pair in a RAID 0/1 or RAID 1 array does not match.

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In Adaptec CI/O Array Management Software you can schedule the Verify operation to run later or schedule it to run at a regularly occurring interval. We recommend that you schedule a verification of all arrays at least once a week. See *Scheduling a New Activity* on page 6-2 for more information.

Follow these steps to verify the integrity of array data:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Verify Integrity of an Array** from the Array Operations menu. The Verify Array window appears with a list of fault-tolerant arrays.
3. Select the array you want to verify.
4. Select **Yes** to allow the program to automatically fix data miscompares, if any are detected. The verification process begins immediately.
5. A message appears indicating that the verification has started successfully. Press **Esc** to remove this message. If you wish, you can press **Alt-Esc** to view a graph showing the progress of the verification process. A window with detailed array information appears above the graph.

   You can perform other tasks in Adaptec CI/O Array Management Software while an array is being verified, as long as the tasks do not interfere with the verification process. For example, you can view information for another array, but you cannot delete the array that is being verified. To abort the array verification, press **F7** and select **Yes** (this is not recommended).
6. Press **Alt-Esc** to return to the other screen and wait for the verification process to finish.

Blinking Member Drive Lights of an Array

If you are not sure which physical disks are members of an array, you can identify them by blinking their drive lights. This works best when no data I/O is occurring. (The lights will already be blinking if data is being written to or read from the array.)

Follow these steps to blink the drive lights of all disks in an array:

1. Select **Disk Array Operations** from the Main Menu.

2 Select **Blink Member Drives of an Array** from the Array Operations menu. A screen similar to Figure 5-2 appears.

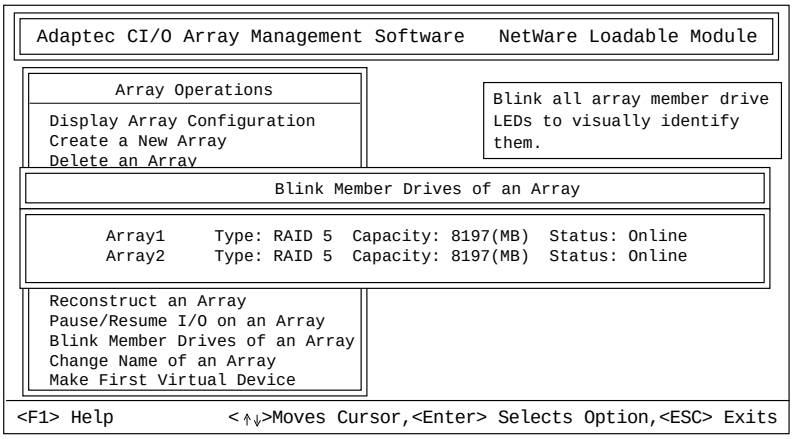

Figure 5-2. Blink Member Drives of an Array Window

3 Highlight the array whose lights you want to blink and press **Enter**.

4 Select **Yes** to confirm that you want to blink the array lights. A message appears to indicate that the disk lights are blinking.

5 Observe which disk lights are blinking. If the light on a drive that you know is an array member is not blinking, the drive may be disconnected or non-operational.

6 Press **Esc** to remove the message and stop the lights from blinking.

You can also blink the light of a single disk. See *Blinking a Device* on page 5-13.

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Reactivating an Off-line Array

An array may go off-line because a cable is disconnected or because you mistakenly remove the wrong disk when you are replacing a failed disk. Or you may deliberately take the disk off-line. In these situations, the array shuts down temporarily and the integrity of the data on the array is not affected. To determine the status of an array, follow the directions in *Viewing Array Information* on page 4-4.

Follow these steps to reactivate an off-line array:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Reactivate Offline Array** from the Array Operations menu. The Reactivate Array window appears, with all arrays listed.
3. Highlight the off-line array on the list and press **Enter**.
4. Select **Yes** to confirm that you want to reactivate the array. A confirmation message appears, and the array goes online.
5. Read the message and press **Esc** to dismiss it.

Renaming an Array

You assign a name to an array when you create it. Follow these steps to change the name of the array at a later time:

1. Select **Disk Array Operations** from the Main Menu.
2. Select **Change Name of an Array** from the Array Operations menu. A list of arrays appears.
3. Select the array you want to rename from this list and press **Enter**.
4. Erase the current name with the **Backspace** key and type a new name for the array. You can use up to 15 characters, including spaces and any other printable characters.
5. Press **Enter**.
6. Read the event notifications that appear and press **Esc** to remove them.

Forcing the Use of a Spare

You can force a spare to replace a specified disk in an array. A typical use of this operation is replacing a disk in an array when you receive a S.M.A.R.T.[3] alert for the disk. Some types of disk drives generate an alert when the drive is giving indications that it may fail soon. What actually happens when you force a spare is that the disk you select is downed and the spare automatically takes its place. The array does not go off-line when you do this, and you do not need to reboot the server.

Follow these steps to force a spare:

1. Be sure that one or more spares are available for the array. These can be either dedicated spares or pool spares.
2. Select **Disk Array Operations** from the Main Menu.
3. Select **Force the Use of a Spare** from the Array Operations menu. A list of arrays appears in a window.

[3] S.M.A.R.T. stands for Self-Monitoring, Analysis and Reporting Technology. Hard disk drives that support this technology continually analyze their level of reliability and generate an alert if they determine that the disk is likely to fail soon. Adaptec CI/O Array Management Software generates an event notification if it receives a S.M.A.R.T. alert, allowing you to replace the disk before it actually fails.

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4 Select an array and press **Enter**. A list of array members appears, similar to the one shown in Figure 5-3. An error message appears if no available spares are detected.

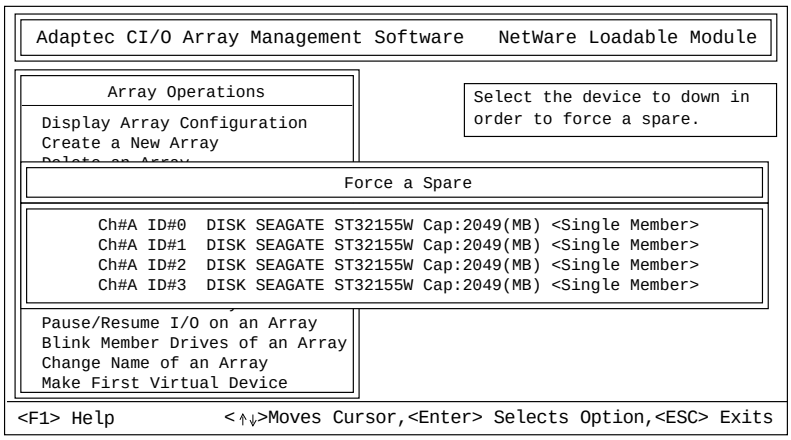

Figure 5-3. Force a Spare Window

5 Select the array member for which you want to force the use of a spare and press **Enter**.

6 Select **Yes** to confirm your choice.

7 Read the messages indicating that the disk has been downed and that a spare is being activated to replace it. Press **Esc** to dismiss the messages.

The spare is automatically activated to take the place of the disk that you indicated. The array does not go off-line while this process occurs, and you do not need to reboot the server.

Note: If both dedicated spares and pool spares are available, the dedicated spares are used first. If there are pool spares, you cannot control which disk from the pool will be activated.

Testing All Spares

Use this option to verify the integrity of all spares in the server. You can perform this operation immediately or schedule it to run later. (See *Scheduling a New Activity* on page 6-2 for more information.)

Note: When you install Adaptec CI/O Array Management Software it automatically sets up a daily Test All Spares operation on the server. We recommend that you leave this default setting unchanged so that all spares are tested regularly.

Follow these steps to test all spares on the server immediately:

1. Select **Spare Pool Operations** from the Main Menu.
2. Select **Test all Spares** from the Spare Pool Operations menu. A message appears indicating that the spares are being tested.
3. Press **Esc** to dismiss the message. Testing all spares takes very little time.
4. Read the popup message that appears when the test is completed. (The message is also recorded in the Server Log and the Event Log.)

   If the message text indicates that any spares failed the test, look in the Server Log. An entry will list the PCI bus number, channel number, and SCSI ID of the failed spare.
5. If there are any failed spares, replace the disks with good disks of at least the same capacity and create new spares from them.

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Performing Device Operations

Downing a Device

Use this option to stop all data I/O to a member of an array. You might need to do this if the disk generates a S.M.A.R.T.[4] alert indicating that it may fail soon. When you down an array member, a spare is activated immediately (if available) to replace it.

Caution: *Do not* down a disk if data is being written to the array. Also, *do not* down a disk on an array in Critical status. If you do, and if data is being written to the array at the time, the array will go off-line automatically, and data could be lost.

Follow these steps to down a device:

1. Select **Device Operations** from the Main Menu.
2. Select **Down a Drive** from the Device Operations menu. A list of drives appears.
3. Highlight a drive on the list and press **Enter**.
4. Select **Yes** to confirm that you want to down the drive.
5. Read the event notification message that appears and press **Esc** to dismiss it.

A spare is activated at this point, if one is available, to replace the downed drive, and the new array member is reconstructed. A message appears when the operation is completed.

[4] S.M.A.R.T. stands for Self-Monitoring, Analysis and Reporting Technology. Hard disk drives that support this technology continually analyze their performance and generate an alert if they determine that the disk is likely to fail soon. Adaptec CI/O Array Management Software generates an event notification if it receives this alert, allowing you to replace the disk before it actually fails.

Pausing I/O to a Drive

Use this option to pause all data I/O on a disk drive. You might need to do this if you want to replace the disk and the array enclosure does not support hot swapping[5]. When you pause a drive, *all* other drives connected to the Adaptec Array1000 Family product are paused as well. I/O resumes automatically after a specified pause interval.

Follow these steps to pause I/O to a drive:

1. Select **Device Operations** from the Main Menu.
2. Select **Pause/Resume I/O on Drive** from the Device Operations menu. The Pause Device window appears with a list of drives.
3. Highlight the drive you want and press **Enter**.
4. Read the message and enter a pause period that does not exceed the maximum pause period.

Note: The minimum pause period is 5 seconds; the maximum pause period is 120 seconds.

5. Press **Enter** to pause I/O.
6. Do whatever you need to do to the disk, such as reconnecting a cable or replacing a disk. Be sure you complete your work before the end of the pause period.

   A rescan is done automatically when I/O is resumed.

You can also pause data I/O to an array. See *Pausing I/O on an Array* on page 5-3.

[5] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad drive is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

Blinking a Device

If you are not sure which physical disk corresponds to a particular SCSI ID, you can identify it by blinking its drive light. This works best when no data I/O is occurring, since the light will already be blinking if data is being written to or read from the disk.

Follow these steps to blink the drive light of a disk device:

1. Select **Device Operations** from the Main Menu.
2. Select **Blink a Device** from the Device Operations menu. A screen similar to Figure 5-2 appears.
3. Highlight the disk whose light you want to blink and press **Enter**.
4. Select **Yes** to confirm that you want to blink the device's light. A confirmation message appears.
5. Observe which light is blinking in the RAID enclosure.
6. Press **Esc** to remove the message and stop the light from blinking.

You can also blink the lights of all disks in an array. See *Blinking Member Drive Lights of an Array* on page 5-5.

Setting the Remote Access Password

No password is required to run Adaptec CI/O Array Management Software from a NetWare server console. However, users who run the networked client version of the program must enter a password before they make any changes to array configuration. The network administrator controls the password.

The NetWare version of Adaptec CI/O Array Management Software allows the network administrator to set the server's remote access password initially from the server console and to change the password at any time. See Chapter 12, *Setting Security Options*, for more information about setting and using the password.

Caution: When you install Adaptec CI/O Array Management Software on a server, you must initially set the password *from the server*. Remote users *cannot access* server information until the password is set.

Follow these steps to set the server's remote access password:

1. Select **Set Remote Access Password** from the Main Menu. The screen shown in Figure 5-4 appears.

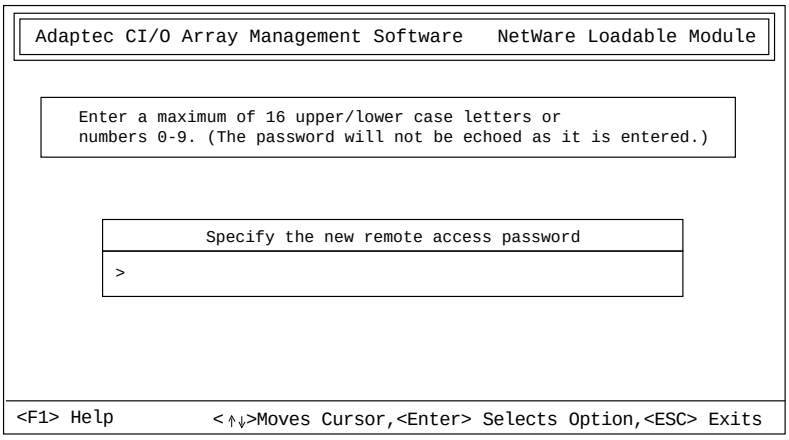

Figure 5-4. Remote Access Password Screen

2. Type the new password, using any combination of upper- or lower-case letters and the numerals 0-9. Then press **Enter**. Passwords are case-sensitive and can be up to 16 characters long.
3. When you are prompted, type the new password again and press **Enter**. A message appears notifying you that the password has been changed.
4. Press **Esc** to remove the message from the screen.

Users must now enter the new password to monitor the server from a networked client on which Adaptec CI/O Array Management Software is running.

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6

Scheduling and Monitoring Array Activities

Adaptec CI/O Array Management Software allows you to schedule the following kinds of array activities to run at a later time or to run at a regularly occurring interval:

- Verify Array
- Reconstruct Array
- Test All Spares

The advantage of scheduling these activities instead of running them immediately is that they can be done at a time when few users are logged on to the server and when slower data I/O performance will not be a problem. Also, the system administrator does not need to be present to run the activities.

We recommend that you schedule a verify of all arrays at least once a week and that you test all spares daily. Reconstructing an array is done whenever an array enters a Critical status. Reconstruction can be done immediately, or it can be scheduled for a later time when fewer users would be affected by the increased I/O activity.

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Scheduling a New Activity

Follow these steps to schedule a new activity:

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Schedule a New Activity** from the Activity Scheduler menu. A screen similar to Figure 6-1 appears.

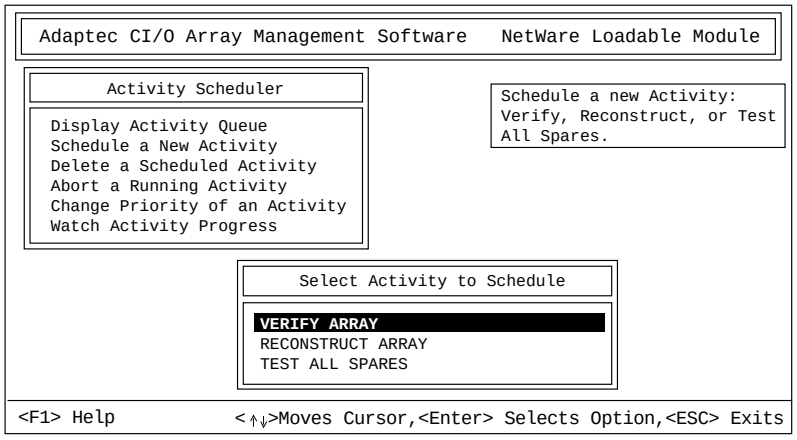

Figure 6-1. Select Activity to Schedule Window

3. Select an activity from the list. A list of arrays appears.
4. Select an array from the list.
   a. If you selected Verify Array, select **Yes** or **No** for the *Auto fix in case of error* option. Then continue with Step 5.
   b. If you selected Reconstruct Array, select the array member to reconstruct. Then continue with Step 5.
   c. If you selected Test All Spares, continue with Step 5.
5. If you are running a Verify or Reconstruct activity, select **Low**, **Medium**, or **High** priority for the activity. (You can change the priority later if you wish. See *Changing an Activity's Priority* on page 6-6 for more information.)

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6 Select one of the following Activity Schedule Modes (enter the options, if any, and press **Enter**):

- **Run Activity Immediately**
- **Run Activity Once**: Select this option to run the activity once at a later time. Then select a day of the week, hour, and minute. Note that a 24-hour clock is used to enter the hour and minute.
- **Run Activity Daily**: Select a start time for the daily activity.
- **Run Activity Weekly**: Select a day, hour, and minute for the weekly activity.
- **Custom Schedule to Run Periodically**: Select an hourly interval for the activity to run (for example, every 10 hours). Specify a date for the activity to start. Specify the hour and minute of the first start time for the activity.

A confirmation message appears on the screen.

7 Press **Esc** to remove the message. The newly-scheduled activity is now an entry in the activity queue.

Viewing the Activity Queue

Follow these steps to view the current activity queue:

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Display Activity Queue** from the Activity Scheduler menu. A screen similar to Figure 6-2 appears.

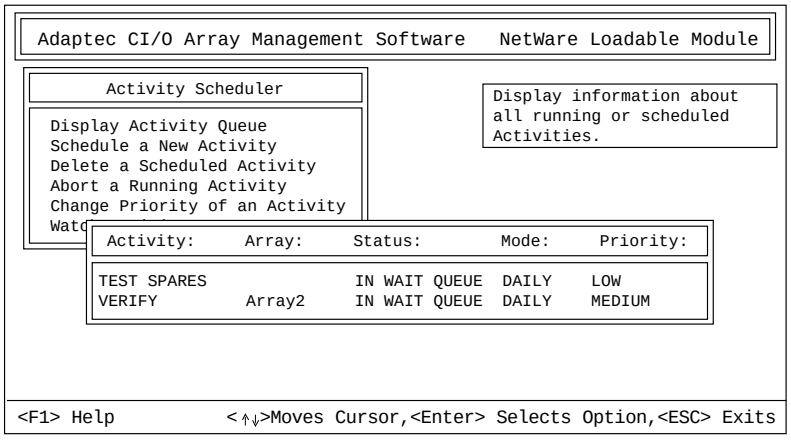

Figure 6-2. Scheduled Activity Information Window

3. View the information in the Scheduled Activity Information window. The activity status can be Running, Complete, Ready, or In Wait Queue.

   Activities that are currently running always appear in the Scheduled Activity Information window, whether they are scheduled or not. For example, if you issue a command to verify an array immediately, the Verify activity appears in the window while it is running.

4. Press **Esc** to continue.

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Deleting a Scheduled Activity

Follow these steps to completely remove a scheduled activity from the activity queue. Use this command only if the activity is *not* currently running. If it is running, first abort it and then delete it:

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Delete a Scheduled Activity** from the Activity Scheduler menu. A screen similar to Figure 6-2 appears.
3. Highlight an activity on the queue and press **Enter**.
4. Select **Yes** to confirm the immediate deletion of the activity.
5. Press **Esc** to dismiss the confirmation message.

Aborting a Running Activity

Follow these steps to abort a running activity. If the activity has been scheduled to run at a regular interval, such as once a day, it will continue to run in the future at the scheduled interval. (If you want to completely delete the activity, follow the instructions in *Deleting a Scheduled Activity* above.)

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Abort a Running Activity** from the Activity Scheduler menu. A list of running activities appears.
3. Highlight an activity on the list and press **Enter** to abort it.
4. Select **Yes** to confirm that you want to abort the activity. An event notification appears.
5. Read the event notification and press **Esc** to dismiss it.

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Changing an Activity's Priority

You can change the priority of Verify and Reconstruct activities while they are running.

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Change Priority of an Activity** from the Activity Scheduler menu. A list of running activities appears.
3. Highlight a Verify or Reconstruct activity and press **Enter**. The Select Activity Priority window appears.
4. Highlight the priority level you want—Low, Medium, or High—and press **Enter**.
5. Read the confirmation message and press **Esc** to delete it.

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Monitoring the Progress of an Activity

Follow these steps to open a window that displays the progress of a scheduled activity that is running:

1. Select **Activity Scheduler** from the Main Menu.
2. Select **Watch Activity Progress** from the Activity Scheduler menu. A list of running activities appears in the Watch Activity Progress window.
3. Highlight an activity in the Watch Activity Progress window and press **Enter**. A Running Activity Progress window appears, as shown in Figure 6-3.

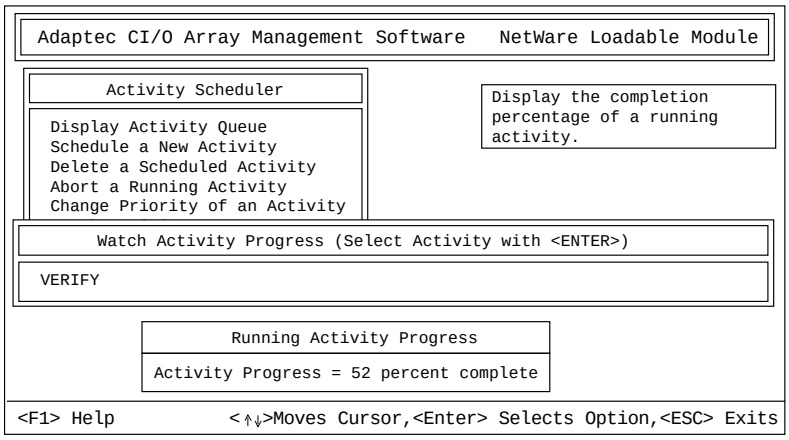

Figure 6-3. Running Activity Progress Window

The Running Activity Progress window shows the percentage of completion of the running activity and disappears when the activity is completed. You can also press **Alt-Esc** to toggle to another screen with a dynamically updated graph of the running activity.

4. Wait until the window disappears, or press **Esc** to remove it and continue.

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▼▼▼▼ Part 3

Using Adaptec CI/O Array Management Software for Windows

▼▼▼▼ 7

Entering and Viewing Client and Server Information

Adaptec CI/O Array Management Software allows you to view information about Array1000 Family storage device events that occur on a single server (if you are running it on a server console), or on multiple servers (if you are running it on a networked Windows-based client). The software also lets you view information about the configuration of Array1000 Family arrays and other storage devices on the server (or servers). This chapter explains how to view this information from Windows-based clients and servers.

Entering and Viewing Server Information

Adding a New Server Address

Note: You only use this procedure when you are running Adaptec CI/O Array Management Software from a networked client.

You must enter information about each server you want to monitor from a networked client with Adaptec CI/O Array Management Software. Once this information is recorded in a configuration file, Adaptec CI/O Array Management Software automatically finds the server(s) when you run the program from this networked client.

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Follow these steps to add a new server address to Adaptec CI/O Array Management Software running on a networked client:

1. Start the program by double-clicking the  icon in the Adaptec CI/O Array Management Software group.

2. Click the  button. The New Server dialog box appears, as shown in Figure 7-1.

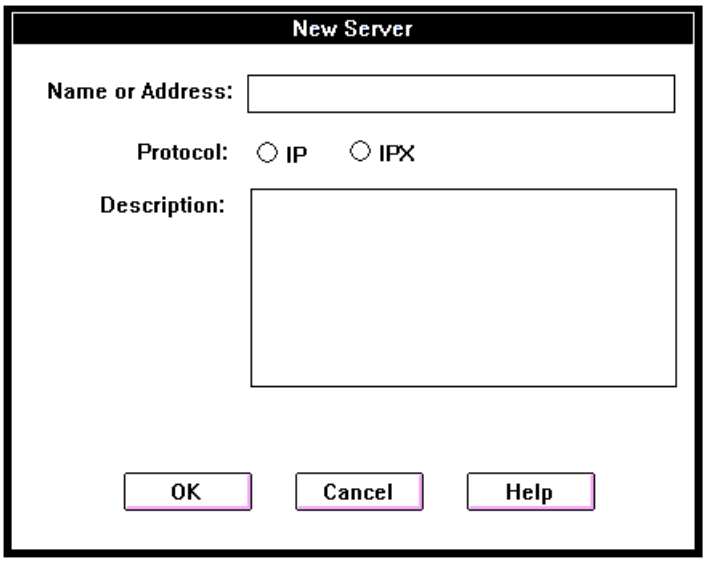

Figure 7-1. New Server Dialog Box

3. Select the **IP** or **IPX** radio button to indicate which kind of access is the default.

4. Enter the server's name or IP/IPX address, which can be up to 32 characters. This name will appear beneath the server icon in the Server View window.

   – Servers running under NetWare usually use IPX protocol. Select the **IPX** button and type the name of the server. To view the server name, open Windows File Manager and select **Network Connections** from the Disk menu. Then view the scrollable list of Data drives. If you get an error

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message when you click **OK** in the New Server dialog box, verify the server name and the use of IPX with the System Administrator.

If you need to enter an IPX address, the format is *xxxxxxxx.xx-xx-xx-xx-xx-xx*, where the first eight *x*'s are hex digits that define the network number, and the six pairs of hex digits are the host address or MAC address.

– Servers running under Windows NT usually use IP protocol. For Windows NT you can always enter the server address, if you know it. Otherwise, enter the server name. This could be something like mainserver or mainserver.unisystem.com. Be sure that your networked client is set up with either a hosts file or with the name of a domain resolver. Ask the System Administrator if you are not sure.

The format of a TCP/IP address is *nnn.nnn.nnn.nnn*, where each group of three decimal digits is a number between 0 and 255 (for example, 123.23.45.145).

5 Enter a description of the server—for example, Application Server or Video Server. This description appears when you double-click the server icon in the Server View window.

6 Click **OK** to add the new server information. You will see one of the following error messages if the server name/address is not correct:

– RPC transport error. This means that you entered a server address with correct IP or IPX syntax, but there is no server with this address. Check your typing for errors and try again.

– Transport not present. This means that you entered an IP address when an IPX address was required, or vice-versa.

– Duplicate server exists. This means that you are trying to enter a server name or address that has already been added for this networked client.

Viewing and Editing Server Information

Follow these steps if you need to enter or change a server's network address information:

1 Click the  button on the toolbar. The Server View window appears. Each server is represented by an icon in the top part of the window. The appearance of the icon indicates the server status, as shown here:

 Server is online and available

 Server is unavailable, perhaps due to a network failure. The networked client will automatically attempt to re-attach to the server every 10 minutes. Double-click the server icon at any time to attempt a re-attach.

 Server has generated a critical event message.

 Server has generated an informational event message

 Guest access to server is disabled. To access server information, double-click the icon and enter the server password when prompted.

 Server has generated a warning event message, such as a message that an array has gone to Critical status

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2 Double-click a server icon in the Server View window. The Server Information dialog box appears, similar to Figure 7-2.

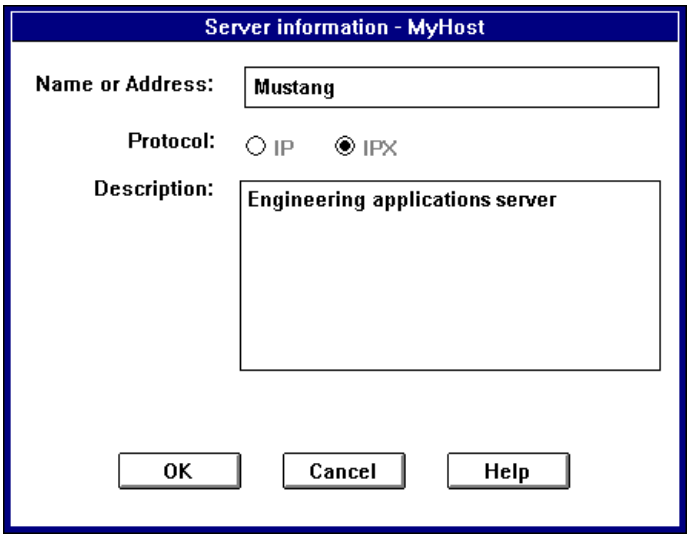

Figure 7-2. Server Information Dialog Box

3 View the server name, IP address, or IPX address.

4 View or edit the server description. The description is for your information only and appears only in this dialog box.

5 Click **OK** to exit the Server Information dialog box and to register any updated server information.

Deleting a Server Address

Note: This procedure applies only to the networked client version of Adaptec CI/O Array Management Software.

When you delete a server address, the icon for the server no longer appears in the Server View window and you can no longer view information for that server or manage it with Adaptec CI/O Array Management Software from the networked client.

Follow these steps to delete a server address:

1. Select **Server View** from the File menu.
2. Click the icon  of the server you want to delete.
3. Select **Server Delete** from the File menu. A prompt appears asking you to confirm the deletion of the currently selected server address.
4. Click **Delete** to delete the server address.

Viewing a List of Current Server Events

When you run Adaptec CI/O Array Management Software on a networked client, you can use the Server View window to monitor events on all servers to which you are connected. Event notifications appear at the top of the list as they are received, starting from the time when you connect to the network. When you run Adaptec CI/O Array Management Software from a server console, you can monitor events occurring on that server only. A color-coded circle at the beginning of each message gives you a quick indicator of its severity.

If you minimize Adaptec CI/O Array Management Software, the icon flashes whenever a new event notification is received.

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Follow these steps to view a list of current server events in the Server View window:

1. Select **Server View** from the File menu. The Server View window appears. The Global Current Event Log at the bottom of this window lists server events, as shown in Figure 7-3.

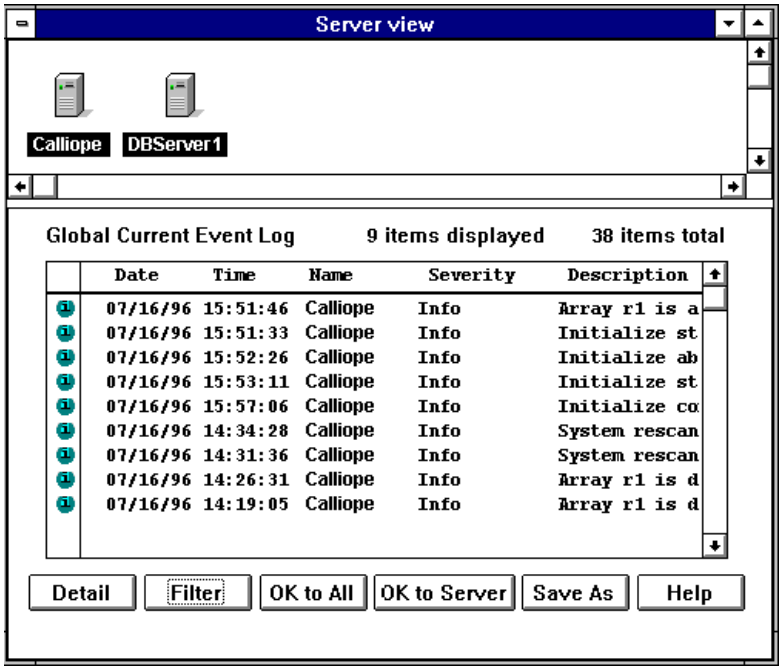

Figure 7-3. Listing of Server Events

2. View the event information for one or all servers. New entries appear on the list as the server events occur, and a date and time is listed for each event. See *Interpreting and Responding to Server Event Messages* on page 7-13 for more information on how to respond to these messages.

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3 To view detailed information about an event, double-click the list entry. The Log Detail dialog box appears, as shown in Figure 7-4.

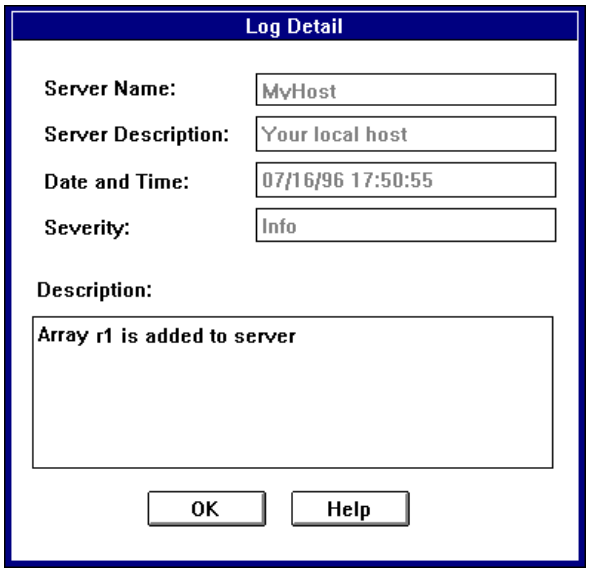

Figure 7-4. Log Detail Dialog Box

The information displayed in the Log Detail dialog box is similar to what appears in the one-line log entry, but the format is more readable.

4 Click **OK** when you are finished viewing the Log Detail dialog box. When you do this, you notify Adaptec CI/O Array Management Software that you have read the event notification.

- To acknowledge all new event notifications *from all servers* without reading each one individually, click the **OK to All** button at the bottom of the Server View window. This will stop the Adaptec CI/O Array Management Software icon from flashing when the application is minimized.
- To acknowledge all new event notifications *from the currently selected server* without reading each one individually, click the **OK to Server** button at the bottom of the Server View window.

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5 Click **Filter** in the Server View window to filter the events notifications in this window by severity. (See *Changing Filter Options* on page 7-9.)

6 Click **Save As** in the Server View window to save the event list to a file.

7 Close the Server View window when you are finished viewing the server events or, if you wish, leave it open so you are aware of server events as they occur.

Changing Filter Options

You can control what kinds of event entries are listed in the Global Current Event Log (part of the Server View window) and the Server Historic Event Log window. You can set the filter options globally, or you can customize them for individual windows. Follow these steps to change the filter settings globally:

1 Click the  button on the toolbar. The Preferences dialog box appears.

2 Click **Filter**. The Default Event Viewing Filter dialog box appears, as shown in Figure 7-5.

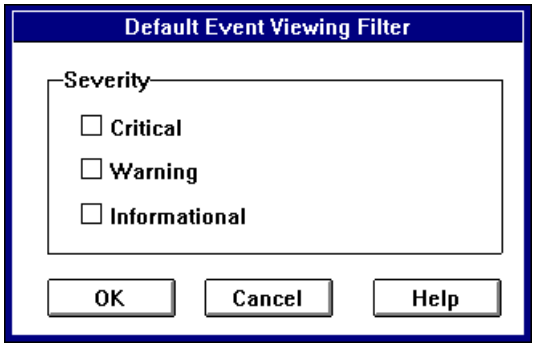

Figure 7-5. Default Event Viewing Filter Dialog Box

3 Select or deselect the **Critical**, **Warning**, or **Informational** entries to control which kinds of messages appear in the Global Current Event Log and the Server Historic Event Log. (We recommend that you select all the boxes.)

If you choose not to display some kinds of messages, the *Items displayed* number above the log entries lists the number of messages that are actually displayed. The *Items total* field always indicates the total number of messages of all types.

4 Click **OK** to record the filter option changes.

If you want to change the filter options only for a specific window, open the Server View or Server Historic Event Log window and click **Filter**. Change the options as described above and click **OK**. The changed settings apply only to this window while it is open; the settings will return to the defaults if you close and re-open the window or if you restart Adaptec CI/O Array Management Software.

Selecting Notification Settings

The notification settings determine how you are notified of events that occur on servers to which Adaptec CI/O Array Management Software is connected. The text describing these events appears in the list of current server events and the Server Historic Event Log window.

Follow these steps to choose notification settings:

1 Click the  button on the toolbar. The Preferences dialog box appears.

2 Click the **Notification** button; the Event Notification Options dialog box appears, as shown in Figure 7-6.

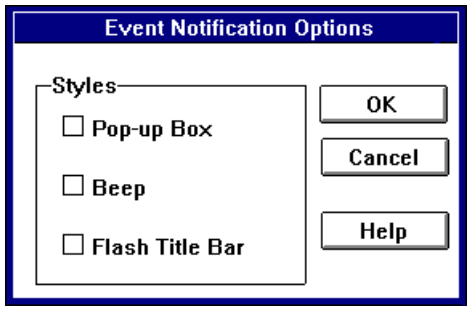

Figure 7-6. Event Notification Options Dialog Box

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3 Select **Pop-up Box**, **Beep**, and/or **Flash Title Bar** to control how you will be notified of events that occur on servers to which Adaptec CI/O Array Management Software is connected.

Note: Regardless of the options you choose, Adaptec CI/O Array Management Software will always notify you of Critical events with a pop-up message, a beep, and a flashing title bar.

4 Click **OK** to save these settings.

Viewing Historical Server Information

You can view a log of historical information for any server to which Adaptec CI/O Array Management Software is connected. This information is retrieved from the server.

Follow these steps to view historical server information:

1 Click the  button on the toolbar. The Server Historic Event Log window for the currently selected server appears, as shown in Figure 7-7.

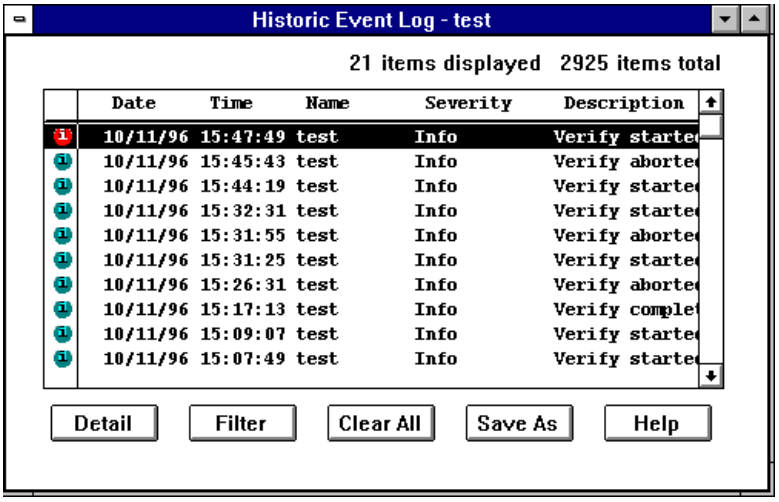

Figure 7-7. Server Historic Event Log Window

2 View the historical information for the server. New entries are added to the top of the list as they occur. A color-coded circle at the beginning of each message indicates its severity. (See the next section, *Interpreting and Responding to Server Event Messages*, for more information.)

3 To view detailed information about an entry on the list, double-click the entry. The Log Detail dialog box appears, as shown in Figure 7-4 on page 7-8.

4 Click **OK** when you are finished viewing the Log Detail dialog box.

5 Click **Filter** to change the message filter options. Click **Clear All** to delete all existing log entries. Click **Save As** to save the log to a file.

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Note: When you open the Server Historic Event Log window, only the most recent log entries are initially retrieved from the server. If you scroll down beyond these entries, another group of entries is retrieved. This avoids the delay that might occur if an entire large log file were retrieved from the server at one time. To keep the Server Log file from getting too large, specify a maximum size for it in the initialization file. (See Appendix A, *Configuration Settings*.)

6 Close the window when you are finished viewing log entries, or minimize it as an icon on the screen.

Interpreting and Responding to Server Event Messages

There are three severity levels for server events:

- **Critical** event messages (red dot) indicate an array or server problem that requires immediate action. An example is an array going off-line because two array members have failed. See *Responding to an Off-line Array* on page 13-3 for more information.

- **Warning** event messages (yellow dot) indicate an array or server problem that may require attention. An example is a paused channel.

- **Informational** event messages (green dot) contain information about some normal operation, such as creating a new array, adding a spare, or verifying an array.

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Entering and Viewing Preference Information

You use the Preferences dialog box to enter or view information about how event notifications are received from servers and to enable and configure password protection for servers and networked clients.

Follow these steps to change or view preferences information:

1 Click the  button. The Preferences dialog box appears, as shown in Figure 7-8.

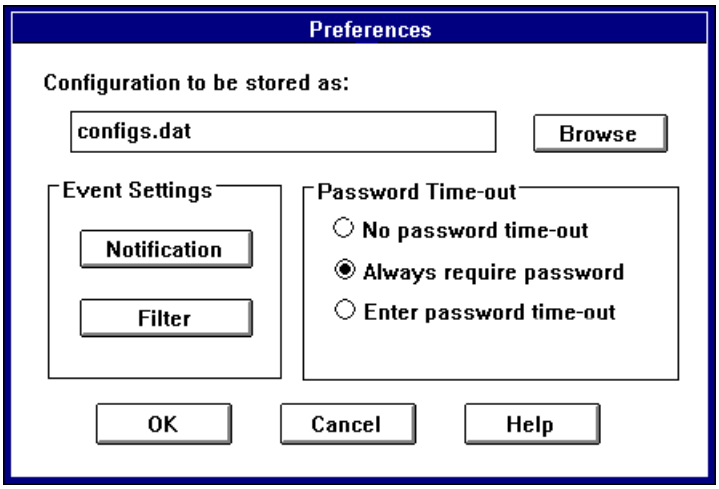

Figure 7-8. Preferences Dialog Box

2 If you wish, enter a different name for the configuration file that is stored on the networked client. Click the **Browse** button if you want to store this file in a different directory on the client's hard disk drive.

The configuration file (*configs.dat*) contains array configuration information for all servers in the server list. Information is automatically written to this file every time you exit from Adaptec CI/O Array Management Software. The next time you start the program, it reads the information from the file so you do not have to re-enter it.

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3 Click the **Notification** button to change the way in which you are alerted of event notifications sent from servers. The Event Notifications Options dialog box appears, as shown in Figure 7-6 on page 7-10. Select one or more of the available options.

4 Click the **Filter** button to view the Log Filter dialog box. By selecting or deselecting the check boxes, you can filter the types of messages that appear in the window. We recommend that you select all the boxes so you are fully informed of server events.

5 Select a Password Time-out option to set the level of password protection for this workstation or server. See *Setting Password Time-out Options* on page 12-4 for more information.

6 Click **OK** to change the option information or to close the dialog box.

Editing the Permanent List

Each server maintains a *permanent list* and an *active list* of networked clients. Clients that communicate with the server are automatically added to the server's active list. Adding a client name to the permanent list allows that client to receive event notifications from the server even when it is not actively monitoring the server. (If a client is on the server's permanent list but not the active list, the server icon does not appear in the Server View window.) You can delete the client name if you no longer want to be notified of events on a particular server.

You can only edit the permanent list from a networked client, not from the server console. When you do this, you are required to enter the server password.

Caution: We recommend that you do *not* use the permanent notification feature for normal communications between servers and networked clients. Servers can use the active list to rapidly communicate new events to networked clients.

Follow these steps to add or delete from the permanent list.

1. Open the Server View window and select the icon of the server whose permanent list you want to edit.
2. Select **Server Administration** from the View menu.
3. Select **Edit Permanent List.** Enter the server's password when you are prompted to do so. The Edit Permanent List dialog box appears, as shown in Figure 7-9.

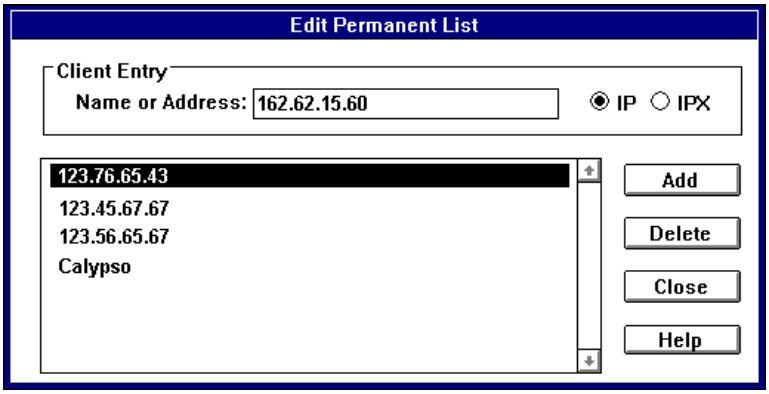

Figure 7-9. Edit Permanent List Dialog Box

   The list box shows the entries that are currently in the selected server's permanent notification list.

4. To add a new networked client entry, type the IP or IPX address in the field at the top of the screen, select the **IP** or **IPX** radio button, and click the **Add** button.
5. To delete a networked client entry, highlight the entry in the list box and click the **Delete** button.
6. Click **Close** when you are finished. The changes are registered in the server's permanent list file.

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8

Configuring Arrays and Spares

This chapter explains how to use the Windows versions of Adaptec CI/O Array Management Software to add and delete arrays and spares. You can do this with the server console version of the program or with the networked client version. The menus and commands are the same for all supported versions of Windows.

Note: If you are using an Adaptec Array1000 Family product in a Windows NT desktop computer system, you should interpret *server* or *server console* to mean *desktop system* wherever the term is used in Part 3 (Chapters 7-12) of this document.

You must know the Adaptec CI/O Array Management Software password if you want to add and delete arrays and spares. See Chapter 12, *Setting Security Options*, for more information.

The following topics are explained in this chapter:

Starting the Program

Follow these steps to start the Adaptec CI/O Array Management Software and prepare to configure arrays and spares. This assumes that the software is already installed and that communications have been established between the server and the networked clients, as explained in the *Installation and Hardware Guide* for your Adaptec Array1000 Family product.

1. Start Windows.

2. Double-click the  icon in the Adaptec CI/O Array Management Software group to start the program.

Note: If you are running Adaptec CI/O Array Management Software from a networked client and the message Guest Access Disabled appears at this point, this means that the server to which you are trying to connect does not allow remote users to view its configuration information. See *Controlling Guest Access* on page 12-5 for more information.

3. If you are running Adaptec CI/O Array Management Software from a server console, skip to Step 5. If you are running Adaptec CI/O Array Management Software from a networked client, open the Server View window by clicking the  button on the toolbar.

Note: If no server icons appear in the upper part of the window, you need to enter information about the servers you want to monitor before you continue. See *Adding a New Server Address* on page 7-1 for more information.

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4 Click the icon of the server whose arrays and spares you want to configure, as shown in Figure 8-1. You can identify the server by the name that appears beneath it.

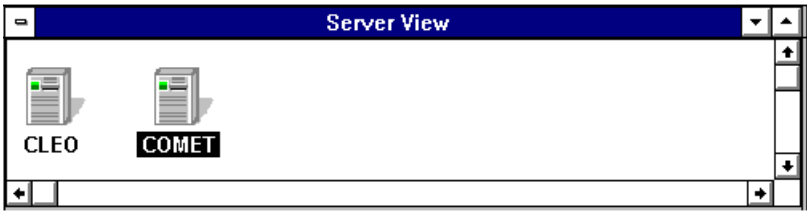

Figure 8-1. Server Icons

If the icon is grayed out, the server is off-line or otherwise unavailable. (See *Entering and Viewing Server Information* on page 7-1 for more information about server icons.)

5 Open the Storage Configuration window by clicking the  icon on the toolbar. All array and spare configuration tasks are done from within this window.

Note: Depending on your system configuration, the Storage Configuration window may open automatically when you start the Adaptec CI/O Array Management Software. See the *How-To Topics* section of the Adaptec CI/O Array Management Software on-line Help for more information about this window.

If you are running Adaptec CI/O Array Management Software from a networked client, you can open other Storage Configuration windows for other servers to which you are connected. To do this, return to the Server View window, select a different server icon, and click the  button again.

Creating an Array

Follow these steps to create arrays with Adaptec CI/O Array Management Software.

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2. This window looks similar to the one shown in Figure 8-2.

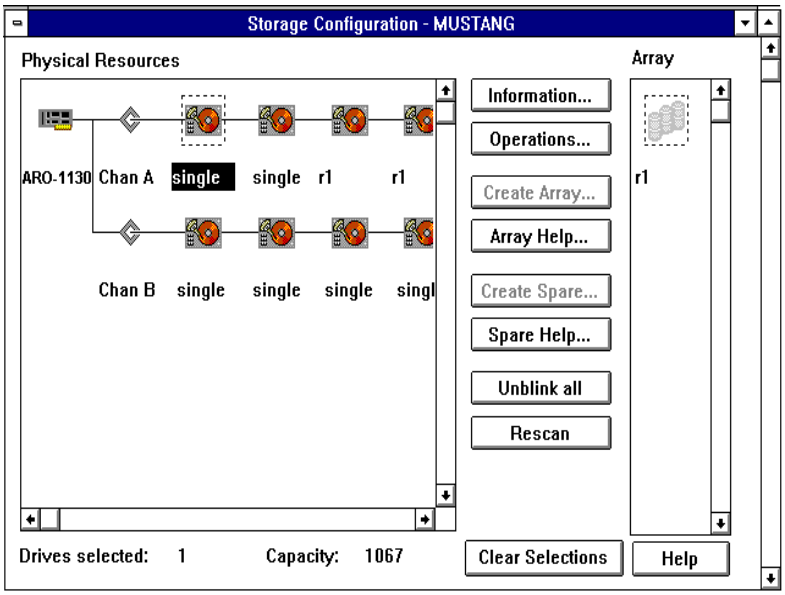

Figure 8-2. Storage Configuration Window

   The icons on the left side of the Storage Configuration window represent the server's *physical resources*—the Adaptec Array1000 Family products, channels, and SCSI devices installed in the server. The icons on the right side represent the server's *Array resources*—the arrays and spares you define. You click the buttons in the middle of the window to perform operations on selected device icons.

2. Before you start defining the new array, decide what RAID level you want to use, how many disks you want it to have, and whether you want to define dedicated spares (spares that can only be used by this array). The following table lists your array options. See *Selecting a RAID Level for an Array* on

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page 13-5 for information on the advantages and disadvantages of each RAID level. Also see Appendix B, *Understanding Arrays and RAID Technology*

RAID Level	Minimum Disks	Maximum Disks[1]	Dedicated Spares	Pool Spares
RAID 0 (Striped)	1[2]	16	None	None
RAID 1 (Mirrored)	2	2	1 or 2	up to 8
RAID 0/1 (Mirrored & Striped)[3]	4	16	1 or 2	up to 8
RAID 5 (Striped, with Distributed Parity)	3	16	1 or 2	up to 8

[1] This is the maximum number of disks supported by the software driver. The maximum for your computer system may be less, depending on how many SCSI channels and devices you have.

[2] The purpose of one-disk RAID 0 arrays is to give you more control over the virtual device order of disks controlled by the Adaptec Array1000 Family product. This is also useful for defining the system's boot device.

[3] RAID 0/1 arrays must have an even number of disks.

3 Select disks for the new array by clicking disk icons  that have the word **Single** beneath them, as shown in Figure 8-3.

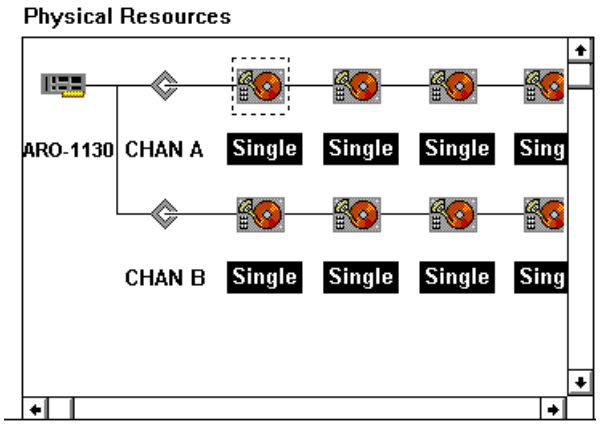

Figure 8-3. Selecting Array Members

Do not include disks that you want to use as spares. Click a second time on an icon to deselect it, or click the **Clear Selection** button if you want to deselect all disk icons.

A warning appears if you select a disk that has a partition. If the operating system recognizes the partition, you *cannot* use the disk in the array. If the operating system does *not* recognize the partition (for example, if the disk was previously partitioned under another operating system), you *can* use the disk in the array.

You are prevented from using disks with recognized partitions for the array so you will not accidentally erase the server's boot disk. To find out if a disk has a partition, double-click the  icon and click the **Check Partitions** button in the SCSI Information dialog box. A small popup box indicates whether the selected disk has a partition and whether the partition is visible to the operating system. If you really want to use a disk with a recognized partition in the array, exit from Adaptec CI/O Array Management Software, back up any data you want to keep, and delete the partition from the disk.

Caution: *All data on a disk is deleted when it becomes an array member! Back up* any data you want to keep before selecting a disk as an array member.

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4 Click the **Create Array...** button. The Create Array dialog box appears, as shown in Figure 8-4.

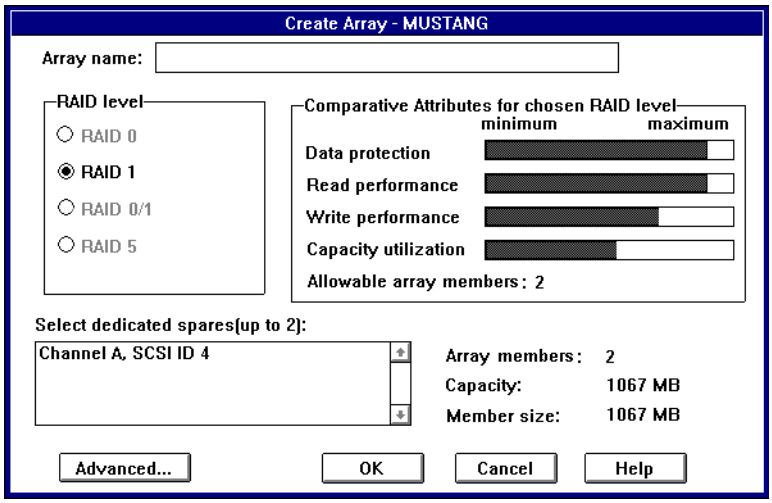

Figure 8-4. Create Array Dialog Box

The number of disks in the array and the array capacity are listed on the right of the dialog box.

5 Type a name for the new array. The name can be up to 15 characters, including spaces and any other printable characters.

6 Select a RAID level for the array by clicking one of the buttons on the left. The bar graphs on the right show you the relative levels of data protection, read performance, write performance, and capacity utilization for each RAID level.

RAID levels are grayed out if they are not consistent with the number of disks you have selected. (See the table on page 8-5.) For example, RAID 0/1 is grayed out if you selected three disks, because a RAID 0/1 array must have at least four disks.

7 Select one or two disks from the list as dedicated spares (if desired). (Use **Ctrl-Click** to select multiple disks.) The disks on the list are the single disks you did not select as array members. The spare(s) you select should be at least as large as the smallest array member. Otherwise the usable capacity of each array member will be reduced to the capacity of the spare.

Note: We recommend using a spare pool instead of dedicated spares. See *Creating Dedicated Spares or a Spare Pool* on page 8-14 for more information. Spares in a *spare pool* can be used by any array on the controller.

8 Click the **Advanced...** button if you want to examine or change the Advanced Array options. The Advanced Array Options dialog box appears. See *Setting Advanced Array Options* on page 8-9 for more information.

9 Click **OK** and then click **Yes** to confirm that you want to create the array. You will see error messages if your array selections are inconsistent. If this happens, change your selections and click **OK** again. You will see a warning if you selected a dedicated spare that is smaller than the array members.

The array is initialized at this point, unless you deselected **auto-initialize** in Advanced Array Options. (If you deselected auto-initialize, skip to Step 11.) If you want to abort the initialization process (not recommended), open the Array Activity Monitor window, select the  icon for that array, and click **Abort**.

10 Wait until the new array is initialized. A popup box will appear to inform you that event notifications are waiting and can be viewed in the Server View window. Then an icon like this  for the new array appears in the right-hand section of the Storage Configuration window. Another event notification is generated when the initialization process finishes.

Note: Event notifications may appear as popups or just as entries in the Server Historic Event Log and Event Log, depending on the Event Notification options you selected in the Client Settings dialog box.

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11 Exit from Adaptec CI/O Array Management Software. Then reboot the server. (You cannot use the new array until you reboot.) You must then partition the new array using the Windows NT Disk Administrator, just as you would partition a new stand-alone disk drive.

Setting Advanced Array Options

The Advanced Array Options dialog box is shown in Figure 8-5. *Do not* change these options from their default settings unless you fully understand what the options mean and you have a specific reason for changing them.

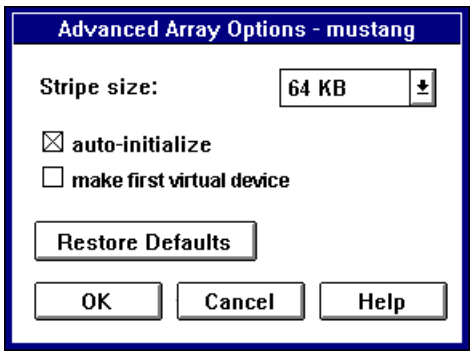

Figure 8-5. Advanced Array Options Dialog Box

Here is a brief description of the advanced options:

- **Stripe Size** is the size that will be used to stripe data or parity information across the disks in the array. The optimal stripe size depends on factors such as the type of data being stored on the array and the server operating system. The default stripe size of 64 KBytes works best in most cases.
- Deselect **auto-initialize** if you want to create the array now but initialize it at a later time. You might want to do this if you plan to define several arrays and initialize them all at the same time.

Caution: All arrays except RAID 0 arrays *must* be initialized or low-level formatted before you can write data to them. We recommend that you zero-initialize RAID 0 arrays as well.

- Click the **Restore Defaults** button if you want to restore the default Advanced Array Options settings.

Note: The *default settings* are the settings that existed when you opened the dialog box. If you change the settings and click **OK**, these become the new default settings for this array.

Making an Array the First Virtual Device

Use this command if you want the server to boot from an array instead of from a stand-alone disk. (If you want to use a stand-alone SCSI disk as your boot device, we recommend that you assign SCSI ID 0 to this device and that you connect it to Channel A of the Adaptec Array1000 Family product.)

You make an array bootable by assigning it virtual device order #0. The *virtual device order* is the sequence in which the server's operating system detects the arrays, single disks, and other devices connected to the Adaptec Array1000 Family product when the server boots. You may also need to move the Adaptec Array1000 Family product to a different PCI slot. See your Adaptec Array1000 Family product's *Installation and Hardware Guide* for more information.

Caution: When you make an array bootable, the drive letters assigned to other drives and arrays on the server may change, which can cause data access problems on your system. You may find it more convenient to create a bootable array with Array*Config*, which gives you more control of the virtual device order of all SCSI devices on the server. See *Making the Array Bootable* on page 2-5 for more information.

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Follow these steps to create a bootable array:

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2.
2. Click the icon  in the right part of the window for the array that you want to make bootable.
3. Click the **Operations** button.
4. Click the  button.
5. When the message appears, click **OK** to confirm that you want to make this array the boot device.
6. Exit from the Adaptec CI/O Array Management Software. If the selected array does not already have a bootable partition on it, reboot the server to a floppy disk.
7. Install the operating system on the array. See your Adaptec Array1000 Family product's *Installation and Hardware Guide* for more information.

The next time you boot the server it will attempt to use this array as the boot device.

Deleting an Array

Caution: Back up the data on an array before you delete it. All data on the array disks is lost when you delete the array.

If you delete an array, all the disks that were part of the array become single, *stand-alone* disks. You can then use the disks as spares or as members of a new array.

Follow these steps to delete an array:

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2.

2 Click the icon  in the right-hand area of the window for the array you want to delete.

3 Click the **Operations** button.

4 When the Array Operations dialog box appears, click the

 button to delete the array.

A warning appears if the selected array has a partition. If the partition is recognized by the operating system, you *cannot* delete the array. If the partition is *not* recognized by the operating system, you *can* delete the array.

You are prevented from deleting an array with a recognized partition so you will not accidentally delete the server's boot array. To find out if an array has a partition, double-click the

 icon and click the **Check Partitions** button in the Array Information dialog box. A small popup box indicates whether the selected array has a partition and whether the partition is visible to the operating system. If you really want to delete an array with a recognized partition, exit from Adaptec CI/O Array Management Software, back up any data you want to keep, and delete the partition from the disk. Then start Adaptec CI/O Array Management Software again and delete the array.

5 When the confirmation message appears, click **OK** to confirm that you want to delete the array.

Note: After you delete an array you can immediately use the disks that formerly belonged to the array to create spares or a new array without rebooting the server. However, you must reboot the server before you can use the disks as single disks that are not members of an array. Deleting an array may change the boot order and the drive assignment.

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Initializing an Array

When you create a new array it is initialized immediately by default unless you deselect the auto-initialize option, as described on page 8-9. If you choose to deselect auto-initialize, you can initialize the array later by following the instructions in this section. You can also reinitialize an array that was previously zero-initialized or low-level formatted.

Caution: All arrays except RAID 0 arrays *must* be initialized or formatted before you can write data to them. We recommend that you zero-initialize RAID 0 arrays as well. All data on the disks is overwritten when you initialize an array.

If you want to low-level format the array instead of initializing it with zeros, use the Array*Config* program. Low-level formatting checks the surface of the disks for defects.

Follow these steps to initialize an array to which data has previously been written or a new array that has been defined but not initialized:

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2.
2. Click the icon  of the array you want to initialize. The Operations button becomes active.
3. Click the **Operations** button.
4. When the Array Operations window appears, click the  button.

   A warning appears if the selected array has a partition. If the partition is recognized by the operating system, you *cannot* initialize the array. If the partition is *not* recognized by the operating system, you *can* initialize the array.

   You are prevented from initializing an array with a recognized partition so you will not accidentally erase the server's boot

array. To find out if an array has a partition, double-click the

icon, and click the **Check Partitions** button in the Array Information dialog box. A small popup box indicates whether the selected array has a partition and whether the partition is visible to the operating system. If you really want to initialize an array with a recognized partition, exit from Adaptec CI/O Array Management Software, back up any data you want to keep, and delete the partition from the disk. Then start Adaptec CI/O Array Management Software again and initialize the array.

5 When the confirmation message appears, click **Initialize** to confirm that you want to initialize the array.

If you want to abort the initialization process (not recommended), open the Array Activity Monitor window, select the

icon, and click **Abort**.

It may take a long time to initialize an array. If you wish, you can watch the progress of the initialization process in the Array Activity Monitor window.

Creating Dedicated Spares or a Spare Pool

Each RAID 1, RAID 0/1, or RAID 5 array can have one or two *dedicated spares*, which automatically replace failed disks *only* for that array. You can create dedicated spares when you create the array, or you can add them to the array at a later time. You can also create a *spare pool* of up to eight disks which automatically replace disks that fail in *any* array on the controller.

We recommend using a spare pool instead of dedicated spares if you have two or more arrays on a controller. Spare pools give you more flexibility and provide good data protection with fewer disks than what is required for dedicated spares.

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Note: When you install Adaptec CI/O Array Management Software it is automatically configured to test all spares on the server once a day to assure they are always available, if needed, to replace failed disks in arrays. We recommend that you leave this default setting so that all spares are tested regularly.

Follow these steps to add a dedicated spare or a pool spare:

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2.
2. Select the disk you want to configure as a spare by clicking on its icon in the left-hand part of the window. (Select a disk that has the word **Single** beneath it.)
3. Click **Create Spare...** The Create Spare dialog box appears, as shown in Figure 8-6. A list of already-defined spares appears on the right. Names of existing arrays appear on the left only if the disk you selected is large enough to protect that array as a spare.

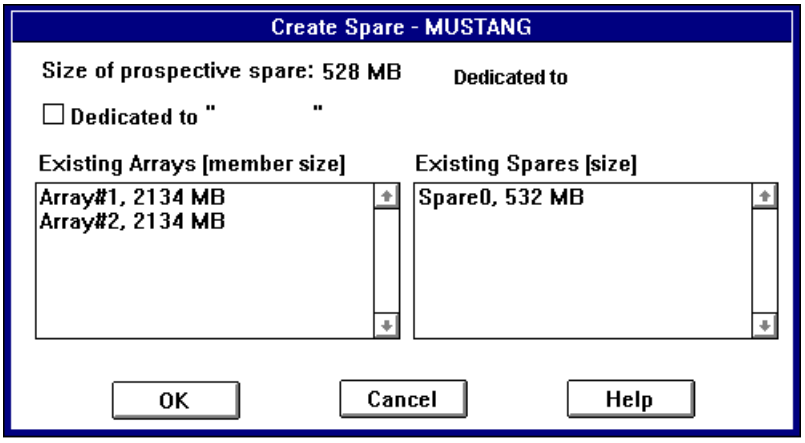

Figure 8-6. Create Spare Dialog Box

Note: In the Storage Configuration window, pool spares are labeled p-spare and dedicated spares are labeled d-spare in both the left and right parts of the window.

4 If you want to dedicate the spare to a specific array, select **Dedicated To** and click the array name in the scrollable list. If you want to add the spare to the pool of spares available to *all* arrays on the controller, do not select the Dedicated To box.

5 Click **OK** to create the spare. A warning message appears if you select a disk that has a partition. If the partition is recognized by the operating system, you *cannot* use the disk as a spare. If the partition is *not* recognized by the operating system (for example, if the disk was previously partitioned under another operating system), you *can* use the disk as a spare.

You are prevented from using disks with recognized partitions so you will not accidentally erase the server's boot disk. To find out if a disk has a partition, double-click the  icon and click the **Check Partitions** button in the SCSI Information dialog box. A small popup box indicates whether the selected disk has a partition and whether the partition is visible to the operating system. If you really want to use a disk with a recognized partition as a spare, exit from Adaptec CI/O Array Management Software, back up any data you want to keep, and delete the partition from the disk.

Newly-created spares are immediately available for use, without rebooting the server. If an array is in Critical status, it will be reconstructed as soon as you have created the spare (unless the spare is dedicated to another array).

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Note: You can add a disk of any size to the spare pool, even if the disk is too small to protect the existing arrays. For example, if you have created two arrays with 1 GByte disks, you can add a 500-MByte disk to the spare pool, even though this disk is too small to replace any failed array member. The spare pool feature is designed like this to give you additional flexibility. For example, you may be planning to create a third array later with 500-MByte disks.

To see which arrays are protected by an existing spare, select the spare in the Existing Spares list; the arrays covered by this spare are highlighted in the Existing Arrays list. You can double-click an array or a spare to view detailed information about it.

Deleting a Spare

You can delete a spare if you want to use it as a stand-alone disk.

Follow these steps to delete a spare:

1. Start Adaptec CI/O Array Management Software and open the Storage Configuration window, as described in *Starting the Program* on page 8-2.
2. Click the icon in the Array part of the window for the spare you want to delete.
3. When the confirmation message appears, click **OK** to confirm that you want to delete the spare.

After you delete an existing spare, and before you reboot the server, you can use a former spare to create a new array or spare. However, this disk does not become visible to the server operating system as a single disk until after you reboot the server.

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9

Viewing Array and Device Information

The Adaptec CI/O Array Management Software allows you to view information about arrays, spares, SCSI channels, and SCSI devices on any server to which you have access.

You view this information in the Storage Configuration window. Follow these steps to open the Storage Configuration window:

1. Select **Configuration** from the View menu, or click the  icon on the toolbar.
2. When the Storage Configuration window appears, double-click the icon that represents the device for which you want to view information. The icons for the more commonly used devices are as follows:
   -  Array
   -  Spare
   -  Controller
   -  Channel

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–  Disk Device

–  CD-ROM Drive

–  Tape Drive

Note: There are also icons for CD changer, SCSI printer, SCSI scanner, etc.

The array and spare icons are virtual devices that appear on the right side of the Storage Configuration window. *Virtual* means that arrays and spares do not exist until you configure them on the server.

The Adaptec Array1000 Family product, channel, and SCSI device icons are physical devices that appear on the left side of the window. *Physical* means that the icons correspond to actual devices installed in the server, such as a SCSI disk drive or a CD-ROM drive.

The following sections explain the information that appears when you click an icon for a virtual or physical device.

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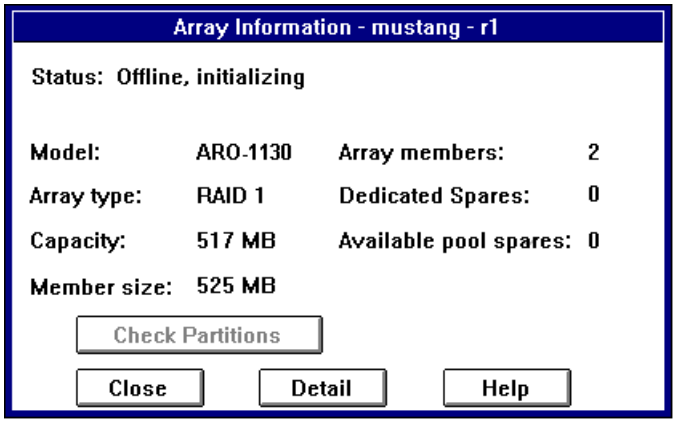
Viewing Array Information

When you double-click an array icon  in the Storage Configuration window, the Array Information dialog box appears, as shown in Figure 9-1.



The following information appears in the Array Information dialog box:

- **Status**: current status of the array, such as OK, Off-line, Fault-tolerant, Critical, etc.
- **Model**: model name of the Adaptec Array1000 Family product to which the array disks are connected.
- **Array type**: RAID level of the array. The supported levels are RAID 0, RAID 1, RAID 0/1, and RAID 5.
- **Capacity**: total usable disk space available in the array, in MBytes.
- **Member size**: size of the array members.
- **Array members**: number of disks in the array.
- **Dedicated spares**: number of spare disks dedicated to this array.
- **Available pool spares**: number of pool spares available to protect this array.

Click the **Check Partitions** button to determine if the array has a partition. A small dialog box indicates whether the selected array has a partition and whether the partition is visible to the operating system.

When you click the **Detail** button, you can view the following additional information about the array:

- **Stripe size**: data and parity striping size used on this array.
- **Virtual device order**: the sequence in which the server's operating system detects this array when it boots. If the array's virtual device order is 0, then this array is the first device the operating system detects at boot time.
- **Creation date**: date on which the array was created.
- **Date of last verify**: date on which the array was last verified. See *Verifying Array Integrity* on page 10-6 for information on how to verify an array.
- **Date of last reconstruct**: date on which the array was last reconstructed. See *Reconstructing an Array* on page 10-2 for information on how to reconstruct an array.

Click **Close** to close the Array Detail and Array Information dialog boxes.

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Viewing Spare Information

When you double-click a spare icon  in the *right* side of the Storage Configuration window the Spare Information dialog box appears, as shown in Figure 9-2.

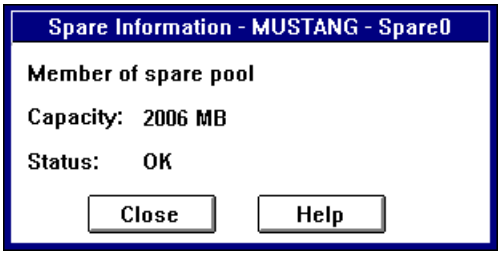

Figure 9-2. Spare Information Dialog Box

If you double-click a spare icon in the *left* side of the window you will see the SCSI Information dialog box, the same as for a single SCSI disk.

The Spare Information dialog box shows which array the spare is dedicated to, whether it is a member of a spare pool, its capacity, and its current status. An *Available* status means the spare is fully functional and is available to replace a failed array disk.

Note: The spare icons in the Storage Configuration window are labeled p-spare for pool spares and d-spare for dedicated spares.

Click **Close** to close the Spare Information dialog box or SCSI Information dialog box.

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Viewing Controller Information

When you double-click a controller icon  , the Controller Information dialog box appears, as shown in Figure 9-3.

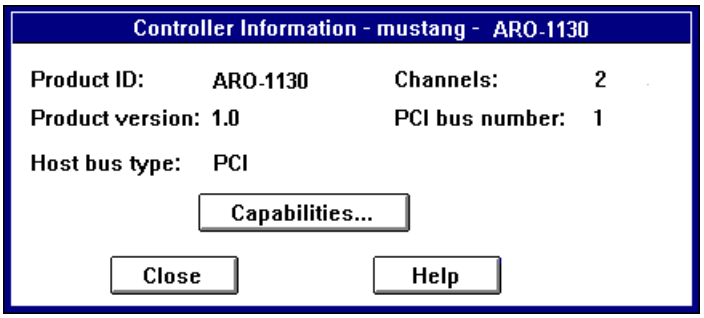

Figure 9-3. Controller Information Dialog Box

The information in the Controller Information dialog box is self-explanatory. The *PCI bus number* field indicates which PCI slot the Adaptec Array1000 Family product is installed in. You may need to know this information if you want to configure the server to boot from an array. For more information, read the server documentation.

Click the **Capabilities** button to view a list of the features supported by this Adaptec Array1000 Family product. The list is informational only; you cannot enable or disable the capabilities on the list. Here is a list of controller capabilities that may appear on the list. (Not all features appear for every product):

- **Auto Verify**: indicates that the product automatically verifies SCSI parity.
- **Auto Fix**: indicates that the product automatically corrects data and parity miscompares.
- **Supported RAID Levels**: lists the RAID levels the product supports.
- **Maximum Number of Spares**: lists the maximum number of dedicated spares per array that the product supports.
- **Maximum Number of Physical Arrays**: lists the maximum number of arrays the product supports.

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- **Maximum Number of Drives for a Single Array**: lists the maximum number of disks the product supports for a single array.
- **Maximum/Minimum Stripe Size**: lists the range of data and parity stripe sizes that the product supports.
- **Spare Pool**: indicates that the Adaptec Array1000 Family product supports using spares from a spare pool.

Click **Close** to close the Capabilities dialog box and the Controller Information dialog box.

Viewing Channel Information

When you double-click a channel icon  , the Channel Information dialog box appears, as shown in Figure 9-4.

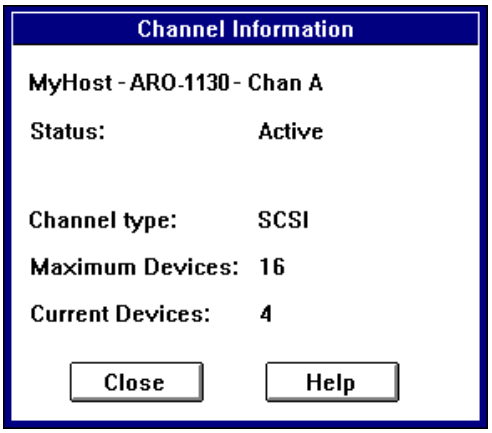

Figure 9-4. Channel Information Dialog Box

The following information appears in the Channel Information dialog box:

- **Status**: current operational status of the channel (for example, Active, Inactive).
- **Channel type**: type of this channel—for example, *SCSI*.
- **Maximum Devices**: maximum number of SCSI devices that the channel supports. If this number is 16 (for example) it

means you can connect up to 15 devices, since the channel itself counts as one device.

- **Current Devices**: number of SCSI devices currently connected to the channel.

Click **Close** to close the Channel Information dialog box.

Viewing SCSI Device Information

When you double-click a SCSI device icon, such as a disk  or a CD-ROM drive  , the SCSI Information dialog box appears, as shown in Figure 9-5.

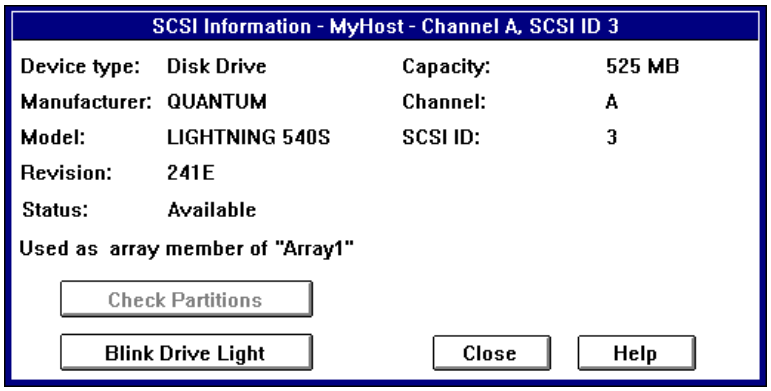

Figure 9-5. SCSI Information Dialog Box

The information in this dialog box is self-explanatory. When you are creating an array you can view this dialog box to determine if a disk you want to use for the array has partitions on it. Simply click the **Check Partitions** button and read the text in the popup window.

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Note: You cannot use a disk in an array if it has a partition that is visible to the operating system. (This prevents you from accidentally deleting data or erasing your boot disk.) If you want to use a disk with a recognized partition in the array, exit from Adaptec CI/O Array Management Software, back up any data you want to keep, delete the partition, and then run Adaptec CI/O Array Management Software again.

Click the **Blink Drive Light** button if you are not sure which physical device the icon represents. The light on the front of the drive will flash briefly. (This option is not available for other kinds of SCSI devices, such as CD-ROM drives.)

Click **Close** to close the SCSI Information dialog box.

Rescanning the Server

Whenever you boot the server the operating system software scans the server for installed devices such as arrays and SCSI devices. Adaptec CI/O Array Management Software displays icons for these devices in the Storage Configuration window.

Sometimes you need to issue a Rescan command while Adaptec CI/O Array Management Software is running so it can "see" the new hardware configuration. You need to do a Rescan if

- you connect a new SCSI device to the Adaptec Array1000 Family product without using the Pause I/O command
- you disconnect a SCSI device from the Adaptec Array1000 Family product without using the Pause I/O command

A Rescan is done automatically whenever you pause I/O and resume I/O to an array or a device. You do not need to issue a Rescan command to detect a failed array member. Adaptec CI/O Array Management Software will detect the failed member automatically if I/O is occurring on the array.

Follow these steps to rescan the server:

1. Click the  button on the toolbar. The Storage Configuration window appears.
2. Click the **Rescan** button, which appears in the area between the Physical Resources and Array areas of the window.
3. When the message appears, click **Yes** to confirm that you want to rescan the server. When the rescan is complete, any hardware changes are reflected in the icons in the Storage Configuration window.
4. Click **OK** when the message appears indicating that the rescan was completed successfully.

Note: You cannot use the Rescan command to recognize an entire array that was transferred from another server. You must reboot the server before it recognizes the transferred array. However, if you remove a disk that is an array member, replace it with another disk, and issue a Rescan command, Adaptec CI/O Array Management Software will detect that the new disk is no longer an array member.

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Performing Array, Spare, and Disk Operations

In Adaptec CI/O Array Management Software you can perform a number of operations on arrays, spares, and stand-alone disks. These operations include verifying the SCSI parity of arrays, reconstructing an array, testing spares, and blinking the lights on one or more disks. Some of the operations are performed immediately; others can be scheduled for a later time, or scheduled to occur periodically at stated intervals.

To perform array, spare, and disk operations you first open the Storage Configuration window. To do this:

1. Select **Configuration** from the View menu, or click the  icon on the toolbar.
2. When the Storage Configuration window appears, *single*-click the icon that represents the array  , spare  , or SCSI disk  you want to work on.

   When you do this, the Operations button becomes active.
3. Click the **Operations** button. The Array Operations, Spare Operations, or Disk Operations dialog box appears.

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4 Click the button for the operation you want to perform. See the appropriate section of this chapter for a description of these operations.

Performing Array Operations

Here is a list of the array operations. Note that some of these operations are described in Chapter 8, *Configuring Arrays and Spares.*

Reconstructing an Array

If a spare disk is available when an array disk fails, the array is automatically reconstructed, and you do not need to use the Reconstruct operation. However, if a disk in an array fails and no spare is available to replace it, you receive an event notification that the array is Critical. You may need to reconstruct the array with this command after the drive is replaced. In either case, data on the array is not lost.

You can reconstruct an array immediately after you replace the failed disk, or you can schedule the reconstruct to occur at a later time. Since the reconstruction process may take a long time, you may want to schedule it for a time when there is less activity on the server.

Follow these steps to reconstruct an array when a disk fails:

1 Determine which array is in Critical status and which disk in the array has failed.

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It is possible that a RAID 0/1 array in Critical status may have more than one failed disk. The array can still be reconstructed without data loss as long as at least one disk of each mirrored pair is still good.

2. If the array enclosure does not support hot swapping[1], pause I/O to the array. (See *Pausing I/O on an Array* on page 10-5.) This is not necessary if the array enclosure does support hot swapping.
3. Replace the failed disk (or disks) with a good disk of at least the same storage capacity. Be sure that the SCSI ID of the new disk is different from the SCSI ID of other installed devices. Or, if an array disk was accidentally disconnected, reconnect it.
4. If you paused I/O in Step 2, wait until it automatically resumes after the pause period. If you did not pause I/O, issue a Rescan command to detect the new disk.
5. If you installed a new disk (or disks), make the disk into a spare by following the directions in *Creating and Deleting Spares* on page 3-12. Be sure the new spare disk is at least as large as the smallest array member.

Note: When the spare is created, Adaptec CI/O Array Management Software should automatically start a Reconstruct operation on the array. If for some reason the reconstruct does *not* begin automatically, follow the remaining steps to perform it manually.

6. Select **Configuration** from the View menu. The Storage Configuration window appears.
7. Click on the array icon that looks like this  . The Operations button becomes active.

[1] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad drive is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

8 Click the **Operations** button. The Array Operations dialog box appears, as shown in Figure 10-1.

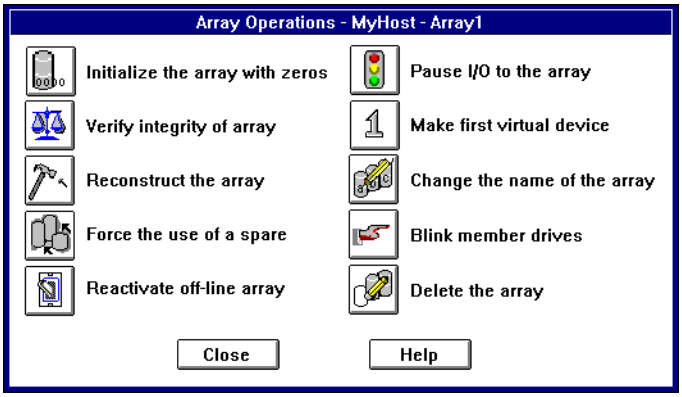

Figure 10-1. Array Operations Dialog Box

9 Click the  button. If the array has one failed drive the Scheduler dialog box appears.

If you have a RAID 0/1 array with two or more failed disks, and at least one disk of each mirrored pair is still good, a dialog box appears with a list of the failed disks. You must reconstruct the disks one-at-a-time, starting over each time at the beginning of these steps. Select one of the drives on the list and click **OK**; the Scheduler dialog box appears. (This assumes that you have already physically replaced all of the failed drives with good drives.)

10 Enter the required information for the Reconstruct operation in the Scheduler dialog box. You can select **Immediate** to reconstruct the drive immediately or select **Once** to schedule the operation for a later time. (See *Setting Scheduling Options* on page 11-1 for more information.)

11 Select an Execution Priority - **high**, **medium**, or **low**.

12 Click **OK**.

13 When the message appears, confirm that you want to reconstruct the array member.

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14 Read the event notifications that appear in the Server View window (they may also appear as popups on the screen) to determine when the reconstruct is complete.

Open a Watch box if you want to monitor the progress of the array reconstruction. (See *Monitoring Activities that are Running* on page 11-5.)

Pausing I/O on an Array

Use this option to pause data I/O on an array while you replace a disk, reconnect a loose connection, etc. If your array enclosure supports hot swapping[2], you probably do not need to pause I/O in order to replace a disk. See the array enclosure documentation for more information.

When you pause an array, all other devices on all channels on the Adaptec Array1000 Family product are also paused. I/O is automatically resumed after a specified pause interval.

Note: The Pause I/O command is disabled if a Verify, Reconstruct, or Initialize operation is running.

Follow these steps to pause and resume I/O on an array:

1 Open the Storage Configuration window and select the icon of the array  you want to pause.

2 When the Array Operations dialog box appears, click the  button.

3 When the Pause I/O dialog box appears, enter a pause interval that does not exceed the maximum allowable pause period,

[2] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad drive is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

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and click **OK** to pause the array. (You may need to enter the server password at this point.) Wait a few seconds until data I/O stops.

Note: The minimum pause period is 5 seconds; the maximum pause period is 120 seconds.

4 Do whatever you need to do with the array disks. Data I/O resumes automatically at the end of the pause period.

Verifying Array Integrity

Use this option to verify the integrity of redundant data stored on fault-tolerant (RAID 0/1, RAID 1, RAID 5) arrays. When you run this operation, Adaptec CI/O Array Management Software checks the array for miscompares and corrects parity errors automatically. A *miscompare* occurs when the parity information on a RAID 5 array does not match the user data or when some part of the data on a mirrored disk pair in a RAID 0/1 or RAID 1 array does not match.

In Adaptec CI/O Array Management Software you can schedule the Verify operation to run later or schedule it to run at a regularly occurring interval. We recommend that you schedule a verification of all arrays at least once a week. See *Setting Scheduling Options* on page 11-1 for more information.

Follow these steps to verify the integrity of redundant array data:

1 Select **Configuration** from the View menu. The Storage Configuration window appears.

2 Click on the array icon  . The Operations button becomes active.

3 Click the **Operations** button.

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4 When the Array Operations dialog box appears, click the  button to verify the data on the array. The Scheduler dialog box appears, as shown in Figure 10-2.

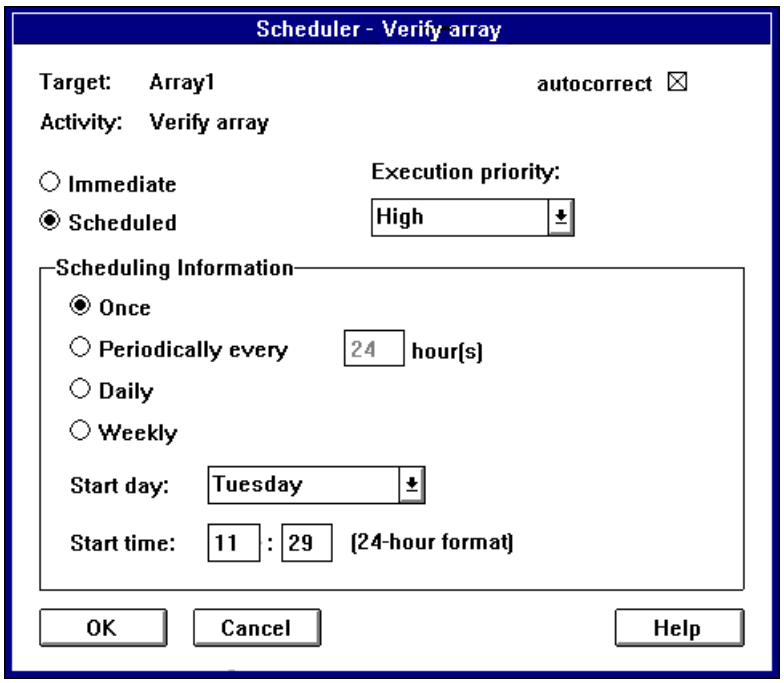

Figure 10-2. Scheduler Dialog Box

5 Leave the **autocorrect** box checked so that any data parity or mirroring mismatches will be corrected automatically.

6 Select **Immediate** if you want to verify parity immediately, or select **Scheduled** if you want to schedule the operation for a future time.

7 If you select **Scheduled**, enter a start time, start day of the week, and other information. (See *Setting Scheduling Options* on page 11-1 for more information.)

8 Select an Execution priority - **high**, **medium**, or **low**. This determines how much system resources are devoted to the operation. A high priority means the Verify operation will use

a lot of system resources, which may slow down other system activity.

9 Click **OK** to start the operation (if you selected Immediate) or to enter it on the list of scheduled activities.

10 When the message appears, confirm that you want to verify parity information.

You can open a Watch window to monitor the progress of the operation as it is running. See *Monitoring Activities that are Running* on page 11-5 for more information.

Blinking Array Drive Lights

You can issue a command to blink the drive lights of all the disks in a selected array. This allows you to see which physical drives actually form the array.

Follow these steps to blink the drive lights of the disks in an array:

1 Select **Configuration** from the View menu. The Storage Configuration window appears.

2 Click on an array icon in the right side of the dialog box. The Operations button becomes active.

3 Click the **Operations** button.

4 When the Array Operations dialog box appears, click the  button.

5 Look at the array enclosure to see which disks are members of the array.

6 Click the **Unblink all** button in the Storage Configuration dialog box to stop the drive lights from blinking.

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Reactivating an Off-line Array

An array may go off-line because a cable is disconnected or because you mistakenly removed the wrong disk while trying to replace a failed disk. In these situations, the array shuts down temporarily. Depending on the reason why the array went off-line, it is possible that you can reactivate it and resume I/O without data loss. See *Responding to an Off-line Array* on page 13-3 for more information.

After you correct any hardware problems, follow these steps to reactivate an off-line array:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Click on the grayed-out icon of the off-line array. The Operations button becomes active.
3. Click the **Operations** button.
4. When the Array Operations dialog box appears, click the  button.
5. When the message appears, confirm that you want to reactivate the array. Be sure that any hardware problems are corrected before you do this.

Changing an Array Name

When you create an array, you assign it a name of your choosing. This name appears beneath the array icon and in many of the windows and dialog boxes. It is also used to identify the source of event notifications. You can change this name at a later time, if necessary.

Follow these steps to change the name of an existing array:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Click the icon  of the array whose name you want to change. The Operations button becomes active.
3. Click the **Operations** button.

4 When the Array Operations dialog box appears, click the  button. The Change Name dialog box appears.

5 Type the new array name and click **OK**.

6 When the confirmation message appears, confirm that you want to change the array name. This change appears immediately in the Storage Configuration window.

Forcing a Spare

Forcing a spare means issuing a command for a spare disk to replace a specific disk in an array. You can do this if the array disk is not performing well and is giving some indication that an array member may fail soon. (If an array member actually does fail, a spare replaces it automatically without requiring you to force a spare.)

Follow these steps to force a spare:

1 Be sure that one or more spares are available for the array. These can either be dedicated spares for the array or spares from a spare pool. See *Creating Dedicated Spares or a Spare Pool* on page 8-14 for more information on configuring spares.

2 Select **Configuration** from the View menu. The Storage Configuration window appears.

3 Click on the icon of the array with the suspect disk. The Operations button becomes active.

4 Click the **Operations** button.

5 When the Array Operations dialog box appears, click the  button. This button is grayed out if no spares are available.

6 Select the disk that you want to replace.

7 Click **OK** to replace this disk with a spare.

8 When the confirmation message appears, confirm that you want to replace the disk with the spare.

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At this point data I/O is paused to the disk, and the spare is automatically activated to replace it.

If there is a pool of available spares, you cannot control which disk from the pool is activated when you force a spare. You can control this if there is only *one* dedicated spare or *one* pool spare. If both dedicated spares and pool spares are available, the dedicated spares are used first. An error message appears if the spare is not at least as large as the smallest disk in the array. If this happens, add a larger spare.

Performing Spare Operations

Here is a list of the spare operations available in Adaptec CI/O Array Management Software. (Note that Deleting a Spare is covered in an earlier chapter):

- *Testing All Spares* on page 10-11
- *Blinking the Spare Drive Light* on page 10-13
- *Deleting a Spare* on page 8-17

Note: If you are running Adaptec CI/O Array Management Software from a networked console, all spare operations apply only to the *spares on the currently selected server.*

Testing All Spares

Reliable spares must be available to immediately (and automatically) replace any array disk that fails. Spares should be tested regularly to assure that they are working properly. We recommend that you test all spares daily. You can run this operation immediately by issuing a command, or you can use the Scheduler function to set up a recurring check of all the spares at a time when few, if any, users are logged on to the server.

Note: When you install Adaptec CI/O Array Management Software it automatically sets up a daily Test All Spares operation on the server. We recommend that you leave this default setting so that all spares are tested regularly.

Follow these steps to test all spares:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Click on the icon of any spare on the right side of the dialog box. The Operations button becomes active.
3. Click the **Operations** button.
4. When the Spare Operations dialog box appears, click the  button. The Scheduler dialog box appears, as shown in Figure 10-2 on page 10-7.
5. Select **Immediate** if you want to test all spares immediately, or select **Scheduled** if you want to schedule the operation for a later time.
6. If you select **Scheduled**, enter a starting time, starting day, and other information.
7. Select an Execution priority - **high**, **medium**, or **low**.
8. Click **OK** to start the operation (if you selected Immediate) or to enter it on the list of scheduled activities.
9. When the confirmation message appears, confirm that you want to test the spares.
10. Read the popup message that appears when the test is completed. (The message is also recorded in the Server Historic Event Log and the Server View window.) If any spares failed the test, look at the spare disk icons in the Storage Configuration window. The icons of the failed disks will look like this  .
11. Replace any failed disks immediately with good disks of at least the same capacity.

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Blinking the Spare Drive Light

You can issue a command to blink the drive light of a spare whose icon you have selected. This allows you to see which physical drive is the actual spare.

Follow these steps to blink the drive light of a spare:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Click on a spare icon in the right side of the dialog box. The Operations button becomes active.
3. Click the **Operations** button.
4. When the Spare Operations dialog box appears, click the  button.
5. Look at the array enclosure to see which disk light is blinking.
6. Click the **Unblink all** button in the Storage Configuration window to stop the drive light from blinking.

Performing Disk Operations

You can perform the following disk operations with a single disk or with a selected disk in an existing array:

- *Blinking the Drive Light* on page 10-14
- *Downing the Drive* on page 10-15
- *Pausing I/O to a Disk Drive* on page 10-16

Blinking the Drive Light

You can issue a command to blink the light of a disk whose icon you have selected. This allows you to see which physical disk corresponds to the disk icon.

Follow these steps to blink a drive light:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Click on a disk icon in the left side of the window. The Operations button becomes active.
3. Click the **Operations** button.
4. When the Drive Operations window appears, click the  button.
5. Look at the array enclosure to see which disk light is blinking.
6. Click the **Unblink all** button in the Storage Configuration dialog box when you want to stop the drive light from blinking.

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Downing the Drive

Use this option to stop all data I/O to a member of an array. You might need to do this if the disk generates a S.M.A.R.T.[3] alert indicating that it is about to fail. When you down an array member, a spare is activated immediately (if available) to replace it, and a reconstruct is triggered for RAID levels that support it.

Note: The Down a Drive command can only be used for array members, not for spare disks or single disks.

Follow these steps to down a disk:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Select the icon of the disk you want to pause.
3. Click the **Operations** button.
4. When the Drive Operations dialog box appears, click the  button. If a spare is available, it replaces the downed disk immediately and a reconstruct of the array is triggered.
5. Wait until the Reconstruct operation is completed, and then continue with your work in the program.

[3] S.M.A.R.T. stands for Self-Monitoring, Analysis and Reporting Technology. Hard disk drives that support this technology continually analyze their performance and generate an alert if they determine that the disk is likely to fail soon. Adaptec CI/O Array Management Software generates an event notification if it receives this alert, allowing you to replace the disk before it actually fails.

Pausing I/O to a Disk Drive

Use this option to pause data I/O on a disk drive. You might need to do this if you want to replace the disk and the array enclosure does not support hot swapping[4]. See the array enclosure documentation for more information. When you pause I/O to a disk drive, *all* other devices connected to the Adaptec Array1000 Family product are paused as well. I/O resumes at the end of the pause period.

Note: The Pause I/O command is disabled if a Verify, Reconstruct, or Initialize operation is running.

Follow these steps to pause data I/O to a disk:

1. Select **Configuration** from the View menu. The Storage Configuration window appears.
2. Select the icon of the disk you want to pause.
3. Click the **Operations** button. When the Array Operations dialog box appears, click the  button.
4. When the Pause I/O dialog box appears, enter a pause interval that does not exceed the maximum allowable pause period, and click **OK** to pause the disk. (You may need to enter the server at this point.) Wait a few seconds until data I/O stops.

   Note: The minimum pause period is 5 seconds; the maximum pause period is 120 seconds.

5. Do whatever you need to do to the disk. Be sure to complete your work before the pause period expires. I/O resumes automatically at the end of this period.

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[4] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad drive is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

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Scheduling and Monitoring Array Operations

Adaptec CI/O Array Management Software enables you to schedule certain kinds of operations to run at a later time, or to schedule them to run at regularly recurring intervals. You create these as scheduled jobs at the time you give the command to run the activity, as described in *Verifying Array Integrity* on page 10-6, *Reconstructing an Array* on page 10-2, and *Testing All Spares* on page 10-11.

Setting Scheduling Options

The Scheduler dialog box allows you to schedule the Reconstruct an Array, Verify Integrity of Array, and Test All Spares operations. Reconstruct an Array is a one-time event for which you can enter a date and time. Verify Integrity of Array and Test All Spares can be scheduled as hourly, daily, or monthly recurring events. The Scheduler appears automatically when you define a new scheduled operation.

Follow these steps to set scheduling options for a newly added operation:

1. Define a new scheduled operation: Reconstruct an Array, Verify Integrity of Array, or Test All Spares. The Scheduler dialog box appears, as shown in Figure 11-1.

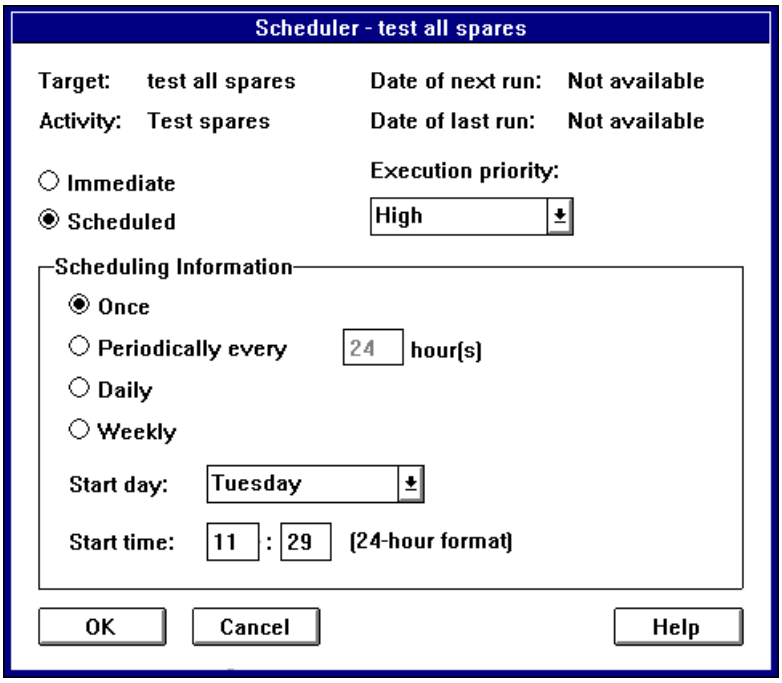

Figure 11-1. Scheduler Dialog Box

2. Select **Immediate** to perform the action immediately or **Scheduled** to schedule it for later.
3. If you select **Scheduled**, select **Once**, **Periodically**, **Daily**, or **Weekly**. Enter other information such as day of the week or start time / date, as required.

Note: If you are scheduling an array reconstruct, you can only select the Once option.

4. Click **OK** to record the scheduling options. You may be prompted to confirm the activity.

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Viewing and Managing Scheduled Activities

You can view information about scheduled and currently running activities in the Array Activity Monitor window. You can abort activities that are running or delete scheduled activities. If you are running Adaptec CI/O Array Management Software from a networked client, the Array Activity Monitor window shows scheduled tasks for the *currently selected server*. To view activities on another server, select the server's icon in the Server View window and open a new Array Activity Monitor window.

Note: When you install Adaptec CI/O Array Management Software it automatically sets up a daily Test All Spares operation on the server.

Follow these steps to view and manage scheduled activities:

1 Select **Activities** from the View menu. The Array Activity Monitor window appears, as shown in Figure 11-2.

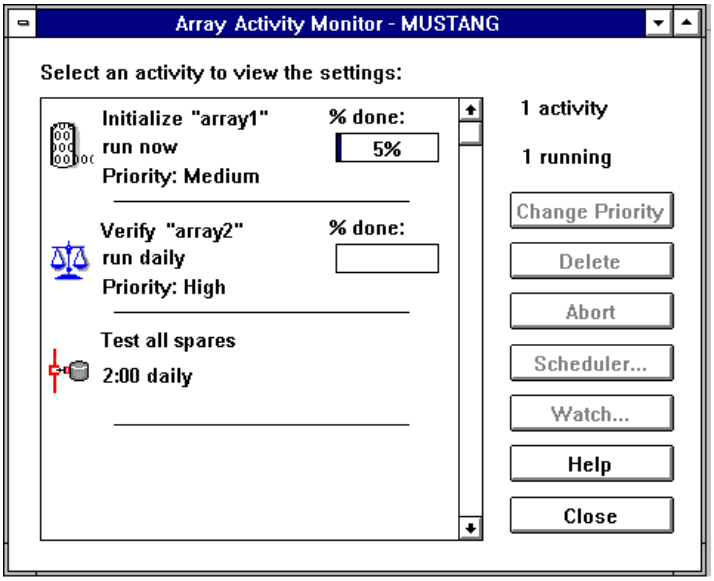

Figure 11-2. Array Activity Monitor Window

2 Select an activity icon from the left part of the window. Information about the activity is shown in the window. Each kind of

activity has a distinctive icon. The icon labels indicate which array or spare the activity applies to.

To view more detailed information about the activity, double-click the activity icon. The Scheduler dialog box appears, as shown in Figure 11-1. Click **Cancel** to close the dialog box.

3 If you want to change the priority of a Verify or Reconstruct operation that is currently running (as indicated by a moving icon), select the activity icon on the left of the window and then click **Change Priority**. When the Change Priority dialog box appears, select an option and click **OK**.

Note: The priority change applies only while the activity is running this time. If it is a regularly scheduled activity, the next time it runs it will have the priority originally assigned to it. You cannot change the priority of an Initialize or Test All Spares operation that is currently running.

4 If you want to delete an activity that is *not* currently running, select its icon and click the **Delete** button. After you confirm the command, the activity is deleted from the list.

5 If you want to abort a currently-running activity, select its icon and click the **Abort** button. After you confirm the command, the activity stops running immediately. If this is a regularly recurring activity, such as a nightly test of all spares, it will run again in the future at the next scheduled time. Use **Abort** and then **Delete** if you want the activity to never run again.

6 Click the **Watch** button to open a small window to monitor the selected, currently running activity. See the following section for more information.

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Monitoring Activities that are Running

You can open one or more Watch windows to monitor currently-running array activities. You can leave these small windows open while you continue doing other work on the computer.

When a Verify operation completes, the Watch window shows the total number of miscompares. A *miscompare* occurs when the parity information on a RAID 5 array does not match the user data or when some part of the data on a mirrored disk pair in a RAID 0/1 or RAID 1 array does not match. If you checked the **Auto Correct** box in the Verify dialog box, the miscompares are automatically fixed.

Follow these steps to monitor activities that are running:

1. Select **Activities** from the View menu. The Array Activity Monitor window appears.
2. Select the icon of a currently-running activity from the scrollable list at the top of the window.
3. Click the **Watch** button. A small Watch window for this activity appears, as shown in Figure 11-3. Each window has a percent complete graph and a Status field (OK, Done, Failed). If a Verify operation is running, there is also a field listing the number of miscompares found. Click **Close** to close the Watch window after the activity has completed.

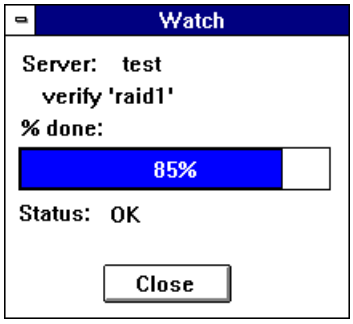

Figure 11-3. Watch Window

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Setting Security Options

Adaptec CI/O Array Management Software has simple but effective password protection to prevent unauthorized changes to array configuration. Users who know the password can view server information *and* can issue commands to add and delete arrays, add and delete spares, and make other changes to array configuration. Users who do not know the password can view server information but cannot change array configuration. The network administrator can disable the Guest Access feature (see page 12-5) on a per-server basis to prevent users who do not know the password from even viewing server information.

The network administrator sets the initial password for each server and controls users' access to passwords.

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Setting the Initial Password

When you install Adaptec CI/O Array Management Software on a server, you must initially set the password from the server console. You *cannot* set the password initially from a networked client. Remote users cannot perform any operations that require password authorization from a networked client until the password is set at the server console.

The password must be set initially for *each* server on which Adaptec CI/O Array Management Software is installed. You can use the same password for all servers, or you can use different passwords.

Follow these steps to set the initial Adaptec CI/O Array Management Software password from the server console:

1. Run Adaptec CI/O Array Management Software on the console of the server whose password you want to set.
2. Select **Server Administration** from the View menu. Then select **Change Password**. The Change Password dialog box appears, as shown in Figure 12-1.

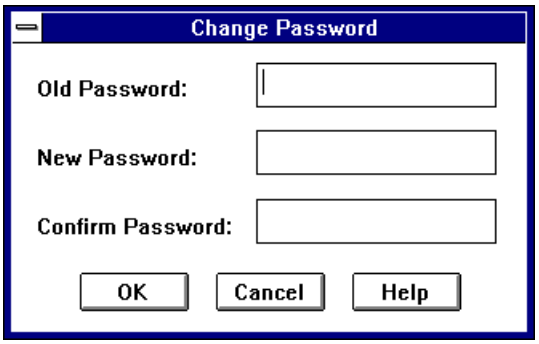

Figure 12-1. Change Password Dialog Box

   No Old Password is required, because none has yet been defined.

3. Type the new password in the New Password field.

   Passwords are case sensitive and can be up to 16 characters long, including the characters A-Z, a-z, and 0-9. Spaces are not allowed. Long passwords with a mixture of numerals and letters provide better security. Do not use obvious passwords like

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your name, the name of a family member, your birthday, your social security number, etc.

4 Type the new password again in the Confirm Password field.

5 Click **OK** to register the initial password.

Changing the Password

After the Adaptec CI/O Array Management Software password is initially set for a server, you can change it either from the server console or from a remote client connected to that server. You must know the current password in order to change the password. We recommend that you change each server's password regularly for better system security.

Follow these steps to change the Adaptec CI/O Array Management Software password:

1 If you are working on a networked client, open the Server View window by clicking the  button. Then select the icon of the server whose password you want to change.

2 Select **Server Administration** from the View menu. Then select **Change Password**. The Change Password dialog box appears, as shown in Figure 12-1.

3 Type the existing password in the Old Password field.

4 Type the new password in the New Password field.

Passwords are case sensitive and can be up to 16 characters long, including the characters A-Z, a-z, and 0-9. Spaces are not allowed.

5 Type the new password again in the Confirm Password field.

6 Click **OK** to accept the new password.

Setting Password Time-out Options

The Password Time-out options allow you to control the way in which users are prompted to enter the server's Adaptec CI/O Array Management Software password when they issue commands to change a server's array configuration. The Password Time-out options are set individually for each networked client.

Follow these steps to change the Password Time-out options:

1. Click the  button on the toolbar. The Preferences dialog box appears.
2. Select one of the three Password Time-out options listed on the right of the dialog box. Here is a description of the options:
   - **No Password Time-out**: Requires you to enter the password only the *first time* (during each session) that you issue a command to change array configuration. This option provides somewhat less security than the others: if you leave your workstation unattended after entering the password, another person can issue commands from the workstation without being prompted for the password.
   - **Always Require Password**: Requires you to re-enter the password *every time* you issue a command to change array configuration.
   - **Enter Password Time-out Interval**: Requires you to re-enter the password at the stated time-out interval, whenever you issue commands to change the array configuration. For example, suppose that the time-out interval is 10 minutes. You start the program at 9:00 and issue a command to create a new array on a server. You are prompted to enter the password before the command is accepted. After entering the password, you issue a command at 9:05 to add spares to the spare pool; no password is required. At 9:16 you issue a command to delete an array; since you are beyond the 10-minute interval, you are prompted again to enter the password before the command is executed.
3. Click **OK** to accept the password time-out change. You may be required to enter the password in order to confirm the change.

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Controlling Guest Access

The Guest Access feature lets the network administrator control who is allowed to view information about the server configuration. Guest Access is enabled or disabled for each individual server; this must be done from a networked client connected to the server. Here is how Guest Access works:

- When Guest Access is *Enabled* (the default), users who do not know the Adaptec CI/O Array Management Software password can view server information from a networked client connected to that server but cannot issue commands to change the server configuration.
- When Guest Access is *Disabled*, users who do not know the Adaptec CI/O Array Management Software password cannot view server information from a networked client or issue commands to change the server configuration. However, users can still view event notifications generated by servers that are on that client's server list. Users who know the password can view server information by double-clicking the server icon and entering the password.

Note: If you *do* know the server's password you can perform array operations such as creating and deleting arrays from any networked client, regardless of whether Guest Access is enabled or disabled.

Follow these steps to enable or disable Guest Access:

1. On the networked client, open the Server View window by clicking the  button. Then select the icon of the server whose Guest Access setting you want to change.
2. Select **Server Administration** from the View menu. Then select **Guest Access**.
3. When the Enable/Disable Guest Access dialog box appears, select or deselect the **Enable Guest Access** check box.

4 Click **OK** to enter the change. Enter the Adaptec CI/O Array Management Software password when you are prompted to do so.

The Guest Access setting is changed on the server.

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▼▼▼▼ Part 4

Managing Arrays and Spares

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Managing Arrays and Spares

This chapter explains what to do when you need to replace a failed drive, physically reconfigure the disks in your server, and perform other tasks.

Responding to a Critical Array

A fault-tolerant (RAID 1, RAID 0/1 or RAID 5) array enters Critical status if one disk in the array fails. The array continues to operate normally, but you may lose data if a second disk in the array fails before the array is reconstructed. (RAID 0/1 arrays can continue operating in Critical status even if two or more disks fail, as long as at least one disk in each mirrored pair remains operational.)

If a spare disk is available, the array management software will reconstruct the Critical array automatically. When the reconstruct is complete, the array returns to Fault-tolerant status. If no spare disk is available, you should respond immediately to minimize the possibility of data loss. The most effective strategy is prevention: be sure that arrays are always protected by a spare pool or by dedicated spares!

In addition, you should monitor the status of arrays at all times with Adaptec CI/O Array Management Software to detect arrays whose status is Critical. You can monitor arrays effectively by enabling the popup event notification option so that a message appears on the screen whenever an array enters Critical status. You can also tell that

an array is in critical status if its icon in the Storage Configuration window looks like this  .

Follow these steps to return a Critical array to Fault-tolerant status:

1. Click the array icon  and observe the disk icons of the array members on the left of the screen. One of the icons should look like this  , indicating that the disk has failed.
2. Click the  icon and then click the **Operations** button.
3. When the Drive Operations window appears, click the  button to blink the drive light on the failed disk.
4. Observe which drive light is blinking. This is the disk that you need to replace. If no lights are blinking, this could mean one of the following:
   a. The disk is still connected but has failed so badly that it cannot respond to the Blink command. Try blinking the drive lights of the array disks that have not failed. You may be able to determine by a process of elimination which disk has failed.
   b. The disk has been removed or its power cord or SCSI cable has been disconnected.

      If an array disk has been disconnected or removed but the server has not been rebooted, the icon for this disk will still appear in the Storage Configuration window. If you know that the disk was disconnected accidentally and has not actually failed, reconnect the drive and resume I/O to the array.

      If the server has been rebooted since the disk was disconnected, the disk will not appear. To determine if a disk is "missing" from an array, double-click the array icon, and read the Status field at the top of the Array Information

dialog box. If this field says Missing member, a disk is missing from the array.

c The disk does not have an LED that indicates I/O activity.

5 If the array enclosure does not support hot swapping[1], pause I/O to the array before you continue. (Skip this step if the array enclosure supports hot swapping.)

6 Replace the failed disk with a good disk, or replace the missing disk. Be sure to complete this step before the pause period expires.

7 After I/O resumes automatically, select the icon of the new disk, and issue a Create a Spare command.

8 When the spare has been created, select the array icon and issue a Reconstruct command, if necessary (it is possible that the reconstruct will start automatically at this point).

When the reconstruct is completed the array is in Fault-tolerant status again, and the array icon will look like this 

Responding to an Off-line Array

You can tell that an array is in off-line status if OFFLINE appears in the array status field in Adaptec CI/O Array Management Software for NetWare or if the icon in the Storage Configuration window looks like this:  . There are several reasons for an array going off-line, as described below:

- A second disk has failed in a RAID 5 array that was critical, or both disks of a mirrored pair have failed in a RAID 1 or RAID 0/1 array that was critical.

[1] *Hot swapping* support means that the array enclosure electrically isolates the bad disk's SCSI connector from the SCSI bus while the disk is being swapped to prevent data corruption. Data can still be transferred to and from the remaining good disks while the bad drive is replaced. Check with the manufacturer of the array enclosure if you are not sure whether it supports hot swapping.

If this happens, delete the off-line array, create a new array, and restore the data from your most recent backup. You cannot recover the array data if a second disk fails.

- You were trying to replace a failed disk in a Critical RAID 1, RAID 0/1, or RAID 5 array, but you mistakenly pulled the wrong disk out of the array enclosure.

  If this happens, reinsert the drive you mistakenly removed and issue the Reactivate Array command, which returns the array to Critical status. Then replace the correct disk, down the server, reboot, and reconstruct the array.

- A cable to a good disk in a RAID 5 array accidentally became disconnected, and the array already had one failed drive; or a cable to a good drive in a RAID 1 or RAID 0/1 array accidentally became disconnected, and the other disk of the mirrored pair had already failed.

  If this happens, reconnect the cable, and use the Reactivate Array command to return the drive to Critical status. Then replace the failed disk and reconstruct the array.

Optimizing Array Performance

If your Adaptec Array1000 Family product has multiple channels, you may be able to achieve better sequential data access with the arrays if some array members are connected to each channel.

The array management software and drivers allow you to use disks of various sizes and makes in the same array. To achieve the best performance, however, we recommend that you use disks of the same capacity and same model in an array. (If you use drives of different sizes, the amount of capacity actually used on each disk will be equivalent to that of the smallest disk in the array: For example, if you use five 1-GByte drives and one 500-MByte drive, only 500 MBytes on each disk will be used.)

You can also optimize array performance by selecting a RAID level for the array that best meets your needs for data reliability, read/write performance, and capacity utilization. See the following section for more information.

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Selecting a RAID Level for an Array

Note: See Appendix B, *Understanding Arrays and RAID Technology*, for more information on RAID technology and on the advantages and disadvantages of the various RAID levels.

The term RAID means Redundant Array of Independent Disks. An array is a grouping of disks that, by means of array management software, appears to the computer's operating system as one large disk. Part of the storage capacity of most kinds of arrays contains redundant information about the user data on the array[2]. If an array disk fails, the contents of the disk can be regenerated on a new disk from the redundant information on the other array disks.

Compared with single disks, arrays can provide one or more of these desirable properties:

- improved Read and Write performance by striping data across the disks in the array. This allows data to be read from or written to two or more disks simultaneously.
- improved data reliability by storing redundant data to regenerate a failed array disk, as described above. This is especially important for servers, where arrays are most often used to store large amounts of mission critical data.
- improved capacity utilization by allowing you to manage a large number of disks as if they were one large disk. This makes it easier to back up data, create directories, etc.

All disks of an array (including spares) must be connected to the same Adaptec Array1000 Family product, though they can be connected to different channels. You can create dedicated spare disks for each RAID 1, RAID 0/1, and RAID 5 array. You can also create a pool of spares that can be used by any RAID 1, RAID 0/1, or RAID 5 array on the Adaptec Array1000 Family product.[3]

[2] RAID 0 arrays, which do not store redundant data, are an exception to this definition.

[3] A disk in a spare pool can only be used to replace a failed disk in an array if it is at least as large as the smallest disk in the array.

The array management software and firmware support RAID 0, RAID 1, RAID 0/1, and RAID 5 arrays. The advantages, disadvantages, and requirements of these RAID levels are as follows:

RAID 0 Arrays
Maximum Disks Allowed: 16[4]
Minimum Disks Allowed: 1[5]

In a RAID 0 array, data is distributed, or striped, across the disks in the array. The capacity of the array is approximately equal to the combined capacity of the physical disks. The I/O performance of a RAID 0 array is much better than that of a single physical disk because multiple reads and writes can be handled in parallel and because when large files are accessed the striped data is retrieved simultaneously from several disks.

RAID 0 arrays do not store redundant data and therefore are not true RAID applications. If one disk fails, the entire array fails and all data is lost. This means that the fault tolerance of a RAID 0 array is less than that of any single disk in the array. The term RAID 0 is widely used for these arrays, however, because they are conceptually similar to true RAID applications.

RAID 1 Arrays
Maximum Disks Allowed: 2
Minimum Disks Allowed: 2

RAID 1 arrays use a single pair of disks. They are called mirrored arrays because both disks in the pair contain the same data. When data is written to a RAID 1 array it is written to each disk in the pair. The read performance of a RAID 1 array can be much better than that of a single disk, while the write performance is slightly worse. Mirrored arrays are highly reliable because the data is still safe if one disk in the pair fails. They are more costly, however, because you only get one disk of actual storage capacity from the pair of disks.

[4] The maximum would be 15 disks if the system has a single SCSI channel.

[5] One-disk RAID 0 arrays are used only to control the virtual device order of single disks.

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RAID 0/1 Arrays
Maximum Disks Allowed: 16 (must be an even number)[6]
Minimum Disks Allowed: 4

RAID 0/1 disks use from two to eight pairs of disks. They are called mirrored arrays because both disks in each pair contain the same data. The read and write performance of a RAID 0/1 array is much better than that of a single physical disk. RAID 0/1 arrays are highly reliable; the array data remains safe so long as at least one disk of each mirrored pair is good. Thus, in a 12-disk RAID 0/1 array, the array could continue working with up to six failed disks if one disk in each pair is still good. Because of the mirrored arrangement, RAID 0/1 arrays require twice as many disks as the actual amount of storage space.

RAID 5 Arrays
Maximum Disks Allowed: 16[7]
Minimum Disks Allowed: 3

RAID 5 arrays contain redundant information in the form of parity data, which is calculated block-by-block for all user data. The parity data is distributed across all the disks in the array and occupies the equivalent capacity of about one disk. User data is interspersed with this parity data. If one disk in the array fails, its data can be reconstructed from the user data and parity data on the other disks. Two disks must fail before the entire array fails. The read performance of RAID 5 arrays is excellent and is comparable to that of a RAID 0 array. Write performance is slower than that of a RAID 0 array, because new parity data must also be calculated and written when user data is written.

[6] The maximum would be 14 disks if the system has a single SCSI channel.
[7] The maximum would be 15 disks if the system has a single SCSI channel.

A

Configuration Settings

This appendix describes the configuration variables that control the appearance of the Adaptec CI/O Array Management Software user interface and the way in which array and system operations are carried out. The variables controlling the user interface appearance are in the Windows NT registry. The other variables are defined in the *iomgr.ini*. and *cioams.ini* files

Many of the variables are configured for you once you install the software or start the program. If you are an advanced user and you want to customize your settings, you can edit the variables in the NT registry, or you can open *iomgr.ini* or *cioams.ini* in a text editor and manually make changes.

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iomgr.ini

The *iomgr.ini* file is located in the directory where the Adaptec CI/O Array Management Software is installed on your server. The section name, for example [ARRAYOPERATIONS], and the variables under each section are described below:

[ARRAYOPERATIONS]

RecreatePriority=

This variable specifies the priority of the automatic Re-create operation. Valid values are Low, Medium, or High. The default is *Medium*.

VerifyIfDirty=

This variable specifies whether you want to start the Verify operation if the array is dirty (meaning that the array was not shut down properly). Valid values are Yes or No. The default value is *No.*

DriverMonitoringFrequencyInSecs=

This variable specifies the maximum interval in seconds before Adaptec CI/O Array Management Software polls the driver. Any number of seconds can be specified; small values affect performance, large values (greater than 10 seconds) affect responsiveness to problems. The default value is *5*.

[SYSTEM]

PauseEnabled=

This variable specifies whether the Pause I/O capability is enabled or disabled. Valid values are Yes and No.

ServerLogSizeInMegabytes=

This variable is used to limit the size of the Server Log database file. The Server Log database will be truncated if it grows beyond the size specified by the parameter. The size can be specified in increments of 1 MByte, up to a maximum of 10 MBytes.

StatisticsCollectionInterval=

This variable specifies the interval at which system statistics will be collected, assuming that the driver supports statistics collection. Values must be entered as whole numbers. The default value is *1*.

WarnAfterFirstPFAEvent=

If set to **Yes**, this variable specifies that if SMART events (PFA) are received from any drive the first event will be reported as a Critical

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event and all events after that will be reported as Warning events. If set to **No**, all SMART events will be reported as Critical. The default is *Yes*.

[TASKS]

TestAllSpares=

This variable schedules the Test All Spares operation. These jobs are not written to the Scheduler Database and are scheduled every time *iomgr.nlm* (NetWare) or *iomgr.exe* (Windows NT) is started. Valid values are

- Yes,H—Starts test every hour on the hour. For example, TestAllSpares=Yes,H
- Yes,D,Time—Starts test daily at a specified time (military time format). For example, TestAllSpares=Yes,D,11:34. (The default value is to test all spares daily at 2:00 A.M.)
- Yes,W,Day of the week,Time—Starts test weekly at a specified day and time (Day of the week: 0=Sun, 1=Mon, 2=Tues., etc.). For example, TestAllSpares=Yes,W,2,11:34 (starts every week on Tuesday at 11:34).
- No—No tests are scheduled. For example, TestAllSpares=No.

[CAPABILITIES]

EnableRAID5=

This variable enables or disables the option of creating RAID 5 arrays. If it is set to **No** users cannot create RAID 5 arrays. Valid values are Yes and No. The default is *Yes*.

EnableRAID10=

This variable enables or disables the option of creating RAID 0/1 arrays. If it is set to **No** users cannot create RAID 0/1 arrays. Valid values are Yes and No. The default is *Yes*.

cioams.ini

The *cioams.ini* file is located in the directory where the Adaptec CI/O Array Management Software is installed on your client. The section name, for example [CORE], and the variables under each section are described below:

[CORE]

ConfigPath=
This variable specifies the default path name for the server configuration file. (The configuration file keeps a record of the server information.) For example, ConfigPath=configs.dat.

[VIEW]

ServerView=
This variable specifies whether the Server View window is displayed when the program starts. Valid values are 0 (is not displayed) and 1 (is displayed). If this variable is not specified, the default is *0*.

[PROTOCOL]

IP=
If set to 1, Adaptec CI/O Array Management Software will attempt to load IP protocol when the program starts.

IPX=
If set to 1, Adaptec CI/O Array Management Software will attempt to load IPX protocol when the program starts.

[RPC ICONS]

Visibility=
Set this variable to Visibility=Hide to hide the RPC services icons when running Adaptec CI/O Array Management Software on a networked client.

[HEARTBEAT]

Interval=
This variable indicates the frequency, in seconds, at which the networked client attempts to connect to the server to get updated information. The default is *10*.

Windows NT User Interface Variables

The Adaptec CI/O Array Management Software user interface variables are located in the Windows NT registry under *HKEY_LOCAL_MACHINE\SOFTWARE\Adaptec\Adaptec CI/O Array Management Software*. These variables apply only to the server console version of Adaptec CI/O Array Management Software, not to the networked client installations:

- Config Path: REG_SZ: configs.dat

  This is the storage path for the configuration file.
- Display Activity: REG_DWORD: 0

  If the value is non-zero, the application will display the Activity Monitor window on startup.
- Display Config: REG_DWORD: 0x2

  If the value is non-zero, the application will display the Storage Configuration window on startup.
- Display Server Log: REG_DWORD: 0

  If the value is non-zero, the application will display the Historic Event Log window on startup.
- Display Server View: REG_DWORD: 0

  If the value is non-zero, the application will display the Server View window on startup. (This is not applicable to the desktop version of Adaptec CI/O Array Management Software.)
- End Date: REG_SZ: 12/31/1999
- End Time: REG_SZ: 23:59:59
- Notifications: REG_DWORD: 0

  Popup Box is 0x1, Beep is 0x2, Flash Titlebar is 0x4, and None is 0x0. These values may be OR'ed together.
- Server Name: REG_SZ:
- Severity: REG_DWORD: 0xd

  Informational is 0x1, Warning is 0x4, and Critical is 0x8. These values may be OR'ed together.
- Start Date: REG_SZ: 1/1/1990
- Start Time: REG_SZ: 00:00:00

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B

Understanding Arrays and RAID Technology

What Is an Array?

An array is defined as *two or more disks grouped together to appear as a single device to the host system*. Figure Figure B-1 illustrates this concept.

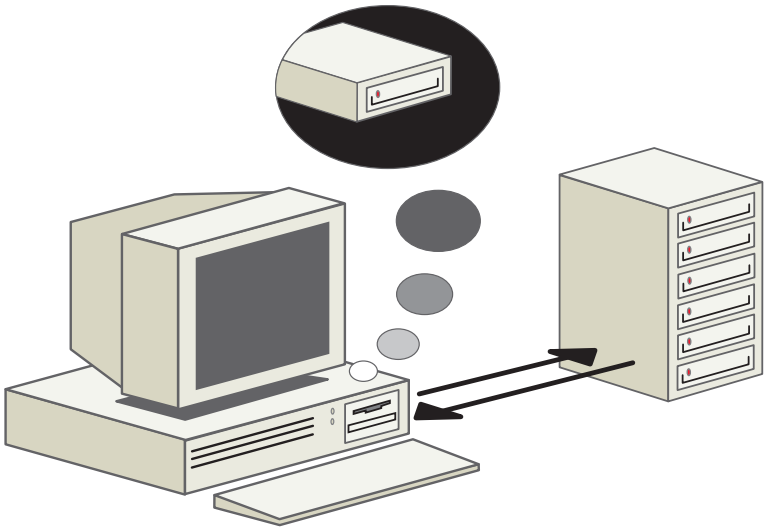

Figure B-1. What Is an Array?

In common usage, the term “array” implies the use of some form of redundancy to increase overall data availability, data integrity, and

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performance. There are several different RAID “levels” or redundancy schemes; each one has characteristics that make it suited to a specific set of applications or network requirements.

Understanding RAID

What is RAID Technology?

RAID technology was first defined by a group of computer scientists at the University of California at Berkeley in 1987. The scientists studied the possibility of using two or more disks to appear as a single device to the host system.

Although the array’s performance was better than that of large, single-disk storage systems, reliability was unacceptably low. To address this, the scientists proposed redundant architectures to provide ways of achieving storage fault tolerance. In addition to defining RAID Levels 1 through 5, the scientists also studied data striping—a non-redundant array configuration that distributes files across multiple disks in an array. Often known as RAID 0, this configuration actually provides no data protection. However, it does offer maximum throughput for some data-intensive applications such as desktop digital video production.

No individual RAID level is inherently superior to any other. Each of the five array architectures is well-suited for certain types of applications and computing environments. For client/server applications, storage systems based on RAID levels 1, 0/1, and 5 have been the most widely used. This is because popular Network Operating Systems (NOSs) such as Windows NT Server and NetWare manage data in ways similar to how these architectures perform.

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The table on page B-19 compares the relative strengths and weaknesses of each RAID level. Figure B-2 illustrates the most popular RAID levels.

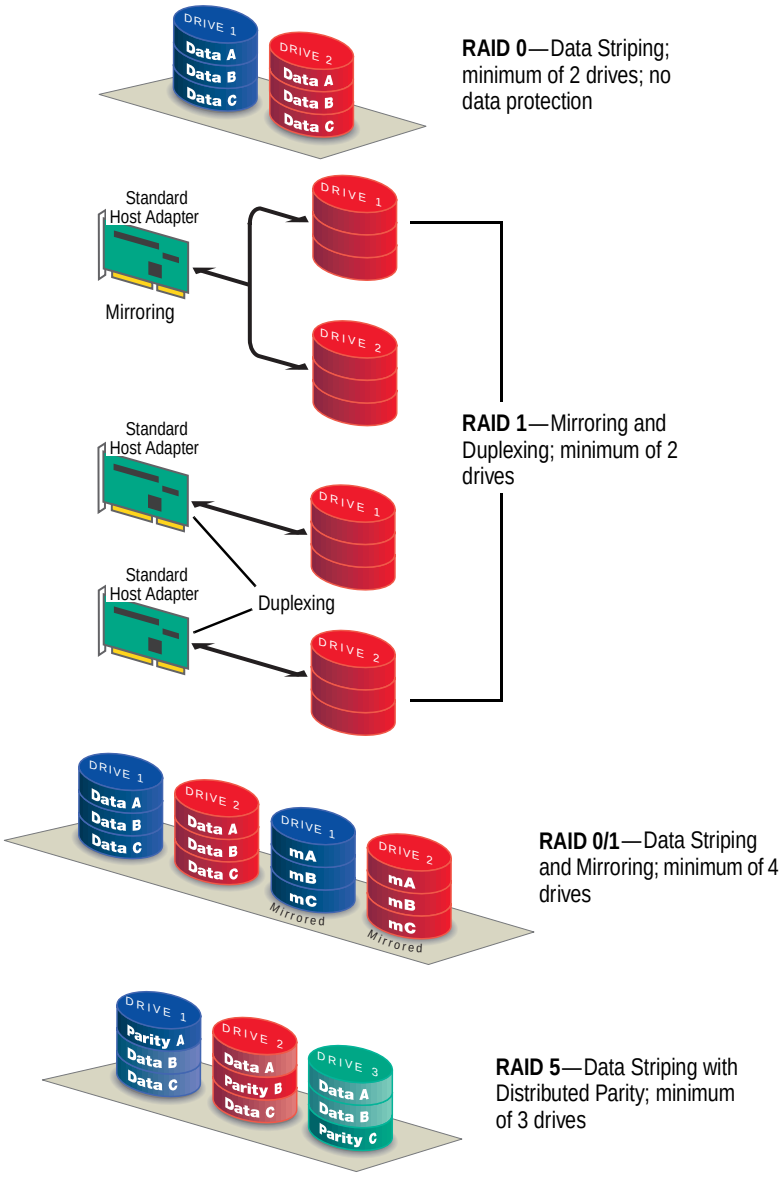

Figure B-2. Popular RAID Levels

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What Does RAID Provide?

RAID technology does not prevent drive failures. However, RAID does provide insurance against business-crippling drive failures by enabling real-time data recovery without data loss.

The fault tolerance of arrays can also be significantly enhanced by choosing the right storage enclosure. Enclosures that feature redundant, hot-swappable power supplies and fans can greatly increase storage system uptime based on a number of widely accepted measures—Mean Time to Data Loss (MTDL), Mean Time of Data Availability (MTDA), Mean Time to Repair (MTTR), and Mean Time Between Failure (MTBF). For brief definitions of these terms, please refer to the *Glossary of RAID Terms* on page B-12.

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Types of Arrays

There are three primary array implementations, as shown in Figure B-3: software-based arrays, bus-based array adapters/controllers, and subsystem-based external array controllers.

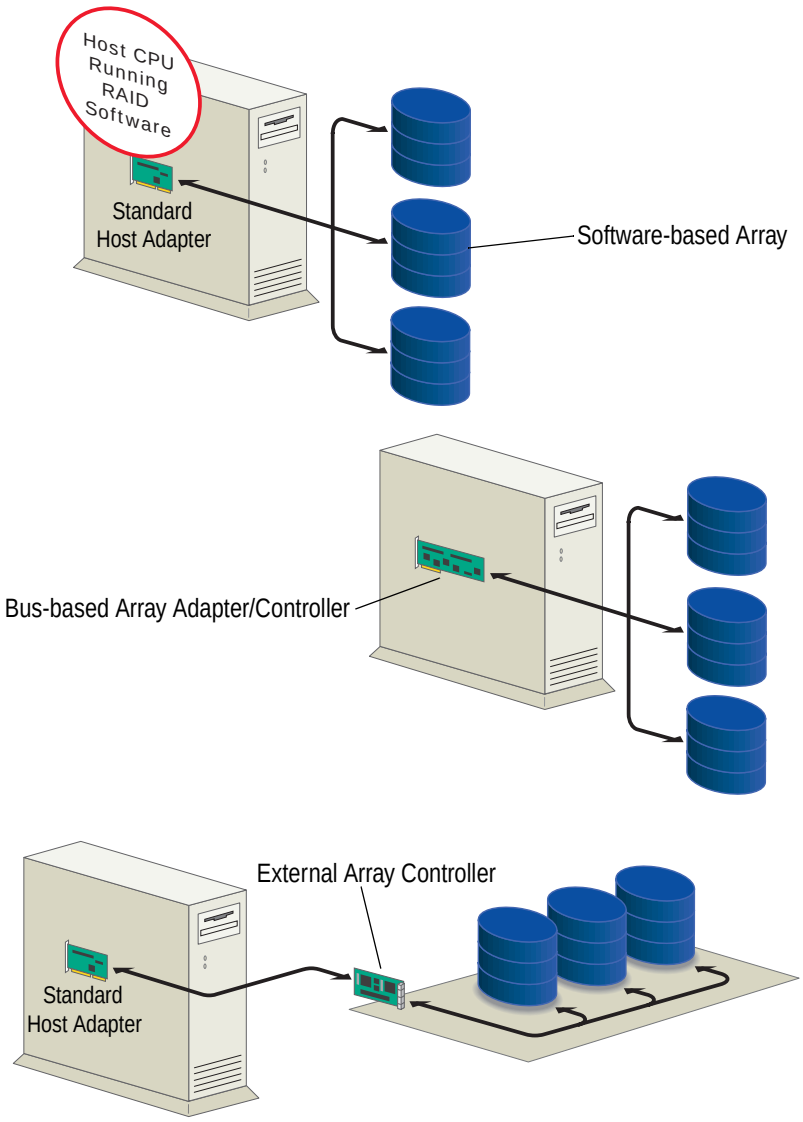

Figure B-3. Array Types

As with the various RAID levels, no one implementation is clearly better than another—although software-based arrays are rapidly losing favor as high-performance, low-cost array adapters become increasingly available. Each array solution meets different server and network requirements, depending on the number of users, types of applications, and storage requirements.

All RAID code is based on software. The difference among the solutions is where the software code is executed—on the host CPU (software-based arrays) or offloaded to an onboard processor (bus-based and external array controllers).

Software-Based Arrays

Primarily used with entry-level servers, software-based arrays rely on a standard host adapter and execute all I/O commands and mathematically intensive RAID algorithms in the host server CPU. This can slow system performance by increasing host PCI bus traffic, CPU utilization, and CPU interrupts. Some NOSs such as NetWare and Windows NT include one or more of the following embedded RAID level software: RAID 0, RAID 1 (mirroring), or RAID 5. The chief advantage of this embedded RAID software has been its lower cost compared to higher-priced RAID alternatives. However, this advantage is disappearing with the advent of lower-cost, bus-based array adapters such as the AAA-130 series and the ARO-1130 RAID-*port* card from Adaptec.

Bus-Based Array Adapters/Controllers

Unlike software-based arrays, bus-based array adapters/controllers plug into a host bus slot (typically a 133-MBytes/sec. PCI bus) and offload some or all of the I/O commands and RAID operations to one or more secondary processors. Originally used only with mid- to high-end servers due to cost, lower-cost bus-based array adapters (such as the AAA-130 series adapters from Adaptec) are now available specifically for entry-level server network applications.

In addition to offering the fault-tolerant benefits of RAID, bus-based array adapters/controllers perform connectivity functions that are similar to standard host adapters. By residing directly on a host PCI bus, they provide the highest performance of all array types. Bus-based arrays also deliver more robust fault-tolerant features than embedded NOS RAID software.

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As newer, high-end technologies such as Fibre Channel become readily available, the performance advantage of bus-based arrays compared to external array controller solutions may diminish.

External Array Controllers (or "Bridge Controllers")

Intelligent external array controllers "bridge" between a servers' I/O interfaces and one or more device channels. These controllers feature an onboard microprocessor that provides high performance and handles functions such as executing RAID software code and supporting data caching.

External array controllers—such as the AEC-4312A and AEC-7312A array controllers from Adaptec—offer complete operating system independence, the highest availability, and the ability to scale storage to extraordinarily large capacities (up to a terabyte and beyond). These controllers are usually installed in networks of Intel-based and UNIX servers and in high-performance clustered environments.

Is Duplexing Effective?

Duplexing—which eliminates the host adapter as a single point of failure—is one of the most popular methods for increasing fault tolerance under RAID 1 (mirroring). Used exclusively with low-performance, software-based RAID solutions, duplexing host adapters alone unfortunately offers no protection against the failure of other server or storage system components. For example, the failure of power supplies and fans, which have relatively low MTBF ratings, can bring down a system more often than a host adapter failure.

Basics of Simple Parity

The concept behind RAID is relatively simple. The fundamental premise is the ability to recover data on-line in the event of a disk failure by using a form of redundancy called parity. In its simplest form, parity is an addition of all the drives used in an array. Recovery from a drive failure is achieved by reading the remaining good

data and checking it against parity data stored by the array, as shown in Figure B-4.

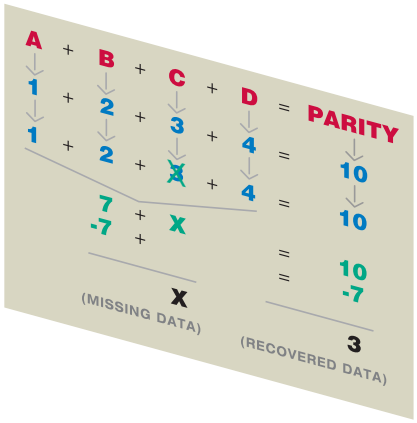

Figure B-4. Parity Calculation

Parity is used by RAID levels 2, 3, 4, and 5. RAID 1 does not use parity because all data is completely duplicated (mirrored). RAID 0, which is used only to increase performance, offers no data redundancy at all.

Building an Array Storage Subsystem

Adaptec array adapters and controllers are the cornerstones of a fault-tolerant storage solution. But building a complete subsystem requires additional hardware components that can greatly enhance the reliability and data availability of an array. These components include the storage enclosure, drives, terminators, and cables.

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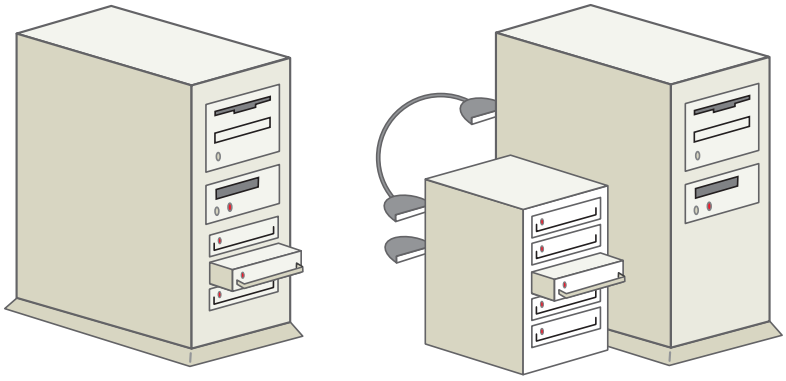
Storage Enclosures

To create an array solution, users can choose from two types of storage enclosures: internal or external, as shown in Figure B-5.



An internal (within the server) RAID solution usually incorporates removable drives to provide an inexpensive, compact, real-time data recovery storage system.

In addition to increased storage capacity, an external RAID solution may provide non-stop features beyond the server's capabilities, such as redundant power and cooling systems.

Figure B-5. Array Enclosure Types

Many entry-level, PCI-based servers now include internal hot-swappable drives for array applications. Both the Adaptec AAA-130 series and the OEM-offered ARO-1130 RAID*port* card are well-suited for these types of servers. *(Visit the Adaptec Web site at www:adaptec.com/RAID to view a list of ARO-1130 PCI RAIDport card OEMs.)*

The second option is to buy an external array enclosure[1] and add drives. When choosing the enclosure, it is important to balance cost with the need for storage system reliability. Various features found in array enclosures—such as redundant, hot-swappable power supplies and fans—can dramatically improve data availability, data integrity, and system serviceability.

[1] For a list of array enclosure manufacturers, see Appendix E of the *AAA-130 Series Installation and Hardware Guide* or the *ARO-1130 PCI RAIDport Card Installation and Hardware Guide.*

Array enclosures also differ in the way they allow drive replacement. Many server and storage manufacturers claim to have array storage systems with removable, hot-swap drive bays. Over the past few years, the term "hot swap" has been applied to everything from being able to replace a drive while on-line and under load to simply permitting the system power to remain on when adding or removing a drive. The latter feature is more correctly referred to as "warm swap."

For true on-line, under-load, hot-swap functionality, users should select a server or an array enclosure that has a SCSI backplane printed circuit board (PCB) or connector on the drive tray with power and ground pins that are *longer* than the data pins. This design ensures that power will always be disconnected *after* the data pins are removed from the SCSI bus and vice-versa. The result is that no power spike "glitches" can occur on the active SCSI bus, thereby avoiding data corruption or loss. For "warm-swap" enclosures, network managers must see to it that all activity on the SCSI bus has ceased before replacing a drive. *To verify whether a particular server or storage enclosure offers hot-swap support, check with the manufacturer.*

Any Adaptec AAA-130 series adapter, ARO-1130 RAID*port* card, AEC-4312A controller, or AEC-7312A controller will provide an effective array solution when choosing an external storage subsystem. With a warm-swap enclosure, Adaptec's CI/O Array Management software gives network managers the added flexibility of pausing activity on the SCSI bus during drive replacement, without affecting the NOS.

Disk Drives

The choice of disk drives can greatly impact the overall performance and capacity of array storage. Drives with relatively high MTBFs and high RPM speeds will fail less often and provide better performance than inferior drives. Keep in mind that mixing drives of different storage capacities will limit the capacity of all drives in the array to that of the lowest-capacity drive. This ensures that there is disk space available for parity information on all stored data.[1]

[1] For a list of popular disk drive manufacturers, see Appendix E of the *AAA-130 Series Installation and Hardware Guide* or the *ARO-1130 PCI RAIDport Card Installation and Hardware Guide.*

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In addition, disk drives equipped with Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.) can be set up to report predicted failures, giving network managers the opportunity to activate a spare drive *before* problems arise.

Adaptec array adapters and controllers support mixing of different capacity drives within the same array. However, Adaptec strongly recommends using drives with similar spindle speeds and capacities to achieve maximum performance and capacity.

Termination and Cabling

Proper termination and high-quality cables should always be used with SCSI devices, particularly when building an array storage subsystem. When implementing Fast, Wide, or UltraSCSI technology, it is a good idea to use active terminators and impedance-matched cables to avoid signal reflections and data corruption. In addition, the maximum cable lengths outlined in the SCSI specification should be strictly followed.

Termination must be at the end of the cable or on the storage enclosure's backplane, not at the device. External array enclosures typically require an external active terminator that attaches to the SCSI connector on the back of the enclosure.[1]

Both the AAA-130 series of array adapters and AEC-4312A[2] and AEC-7312A[2] array controllers are available in kits that include high-quality cabling and active termination.

[1] For a list of SCSI cable kits available from Adaptec, see Appendix D of the *AAA-130 Series Installation and Hardware Guide* or the *ARO-1130 PCI RAIDport Card Installation and Hardware Guide.*

[2] Kits available in subsequent releases.

Glossary of RAID Terms

AAA
Adaptec Array Adapter. For example, the AAA-130 Array Adapter series.

AEC
Adaptec External Controller. For example, the AEC-4312A and AEC-7312A external array controllers.

ARO
Adaptec RAID Option. For example, the ARO-1130 RAID*port* card.

Array
Two or more disks grouped together to appear as a single disk to the host system.

Array adapter
A bus-based (usually PCI) hardware device—such as an add-in card, group of motherboard ASICs, or a combination of both—that converts the timing and protocol of a host's memory bus and an I/O bus. Usually used in entry-level servers, an array adapter also includes an on-board RAID co-processor to offload most of the RAID operations—for example, secondary RAID 1 writes and RAID 5 parity calculations—from the host CPU. This is in contrast to the microprocessor-based array controllers used in midrange and high-end servers, which also offload I/O commands. Array adapters improve performance over software RAID solutions embedded within network operating systems such as NetWare and Windows NT. These adapters provide the same connectivity functions as a standard host adapter.

Bootable array
Allows a server to boot from the array while protecting the network operating system files—and other data on the array—from drive failure.

CI/O
Comprehensive Input/Output. Refers to Adaptec's CI/O Array Management Software.

Clustering
The concept of using independent computer systems working together as a single logical system. Clustering is usually implemented to address both availability and scalability.

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Cold swap
Power must be switched off before the removal or insertion of a component.

Disk array
See *Array*.

Disk/data striping
Spreading data evenly over multiple disks to enhance performance. Sometimes referred to as RAID 0, data striping actually has no redundancy scheme and, therefore, does not provide any fault tolerance (data protection).

Downtime
A period of time during which a network cannot be used due to equipment failure or another cause.

Drive
Synonym for hard drive, hard disk, disk, disk drive.

Duplexing
Mirroring across two host adapters. Used only with software-based RAID storage systems (usually the embedded network operating system RAID software such as NetWare and Windows NT).

Embedded SCSI ASIC (host adapter)
An integrated circuit that is attached directly to the host motherboard and performs the same functions as a standard add-in host adapter. (See *Host Adapter*.)

Exclusive OR (XOR)
A process based on a mathematical algorithm that is used by RAID levels 2, 3, 4, and 5 to compare computer data (binary 0s and 1s) created by a write or read request during a drive failure. The result of the XOR process is parity information that will be stored along with data for real-time data recovery in the event of a disk failure.

External array controller
In contrast to bus-based array adapters and microprocessor-based array controllers, external array controllers reside in the external RAID storage enclosure. They connect to the host through a standard SCSI or serial (such as Fibre Channel) host adapter. These external controllers are similar to bus-based, microprocessor-based array controllers in that they include an on-board microprocessor to offload all RAID functions (I/O commands and RAID operations)

from the host CPU. They are usually used in midrange and high-end servers—especially in clustering environments.

Failed-drive mode
A mode of reduced-performance operation that a disk array is in after a drive failure.

Fault tolerance
The ability of a system to continue to perform its functions, even when one or more components have failed.

Fibre Channel
A high-speed, serial interface capable of supporting data I/O rates of up to 100 MBytes/sec.

Host adapter
A bus-based (PCI, EISA, ISA) hardware device, such as an add-in card or ASIC, that converts the timing and protocol of a host's memory bus and an I/O bus. *Also see Embedded SCSI ASIC and array adapter.*

Hot spare
RAID storage feature that allows a spare drive (or other component) to be configured for automatic (in contrast to hot-swap) replacement and reconstruction in the event of a disk failure. Users can remain on-line and continue to access data. *See also Hot swap and Warm swap.*

Hot swap
A storage system's ability to allow the removal and replacement of a disk drive (or other component) while users are on-line and accessing data. In contrast to hot-spare, this is a manual operation. Hot swap requires that the storage (or server) enclosure drive tray connectors be designed so that when a drive is removed, power is disconnected before the ground connection, and that the ground is restored before the power is reconnected when the drive is reinserted. This is usually accomplished by making the ground pin(s) in the drive tray connector slightly longer than the data pins. *See also Hot spare and Warm swap.*

I/O
Input/output. Refers to network user data requests and host overhead such as swapping and file system activity.

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JBOD
Just a bunch of drives. Refers to an array of drives without data redundancy.

MTBF
Mean time between failure. Used to measure computer component average reliability / life expectancy. MTBF is not as well-suited for measuring the reliability of array storage systems as MTDL, MTTR or MTDA because it does not account for an array's ability to recover from a drive failure. In addition, enhanced enclosure environments used with arrays to increase uptime can further limit the applicability of MTBF ratings for array solutions.

MTDA
Mean time between data access (or availability). The average time before non-redundant components fail, causing data inaccessibility without loss or corruption.

MTDL
Mean time to data loss. The average time before the failure of an array component causes data to be lost or corrupted.

MTTR
Mean time to repair. The average time required to bring an array storage subsystem back to full fault-tolerance.

Member (disk)
A disk that is in use as a member of a disk array.

Microprocessor-based array controller
In contrast to an array adapter, a microprocessor-based array controller includes an onboard microprocessor (for example, an Intel i960) to offload I/O commands and RAID operations from the host CPU. Usually used in midrange and high-end servers. *See also Array adapters.*

Mirroring
Also known as RAID 1, or duplexing (when using two host bus adapters). Full redundancy is obtained by duplicating all data from a primary disk on a secondary disk. The overhead of requiring 100 percent data duplication becomes costly when more than two drives are used.

NOS
Network Operating System. For example, NetWare, Windows NT Server, OS/2, SCO, and UnixWare.

PCI - Peripheral Component Interconnect
An industry-standard specification that refers to a high-speed (133 MBytes/sec.) host bus commonly used for host adapters, Ethernet adapters, and video cards.

Parity
A form of data redundancy used by RAID levels 2, 3, 4, and 5 to recreate the data of a failed drive in a disk array.

RAID
Redundant Array of Inexpensive (or "Independent") Disks. The term coined in 1987 by researchers at the University of California at Berkeley to describe a series of redundant architectures used in fault-tolerant disk arrays.

RAID Advisory Board (RAB)
Industry organization of manufacturers and users of disk systems and related products whose mission is to educate users regarding all aspects of storage technology, and in particular, RAID technology.

RAID levels

Numbered 0 through 5, RAID levels refer to different array architectures that offer various advantages in terms of data availability, cost, and performance.

Redundant
A duplicate disk or component that provides a recovery path in case of a failure.

SCSI
(Pronounced *scuzzy*) Small computer system interface. The fast, intelligent, input/output parallel bus used by high-performance peripheral devices.

SIMM
Single in-line memory module.

SLED
Single Large Expensive Disk. Refers to older mainframe hard disks that were used as a basis for comparison during the initial UC Berkeley RAID studies.

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S.M.A.R.T.
Self-Monitoring, Analysis and Reporting Technology. Drives equipped with this feature report predicted failures based on threshold values determined by the manufacturer. This allows the network manager to replace a drive before it fails.

Software-based arrays
An array in which all management functions including mathematically intensive parity calculation (XOR) are performed by the host server CPU. These products are low-priced but have high CPU utilization and limited fault-tolerant features. High-performance, low-cost array adapters (such as the AAA-130 series and the ARO-1130 RAIDport card) are quickly replacing these inferior software-based arrays.

System disk
The disk (or array) on which a system's operating system is stored and from which it is initially loaded into system memory. (See also *Bootable array*.)

Usable storage capacity
Disk array capacity that is usable for data storage (as opposed to for mirroring or parity data). For example, in a mirrored (RAID 1 and 0/1) array, usable storage remains a constant fifty percent (half of storage is always used for redundancy). This is in contrast to other RAID levels such as RAID 5, in which usable storage capacity is determined by the formula of "n-1" (where "n" is the total number of disk drives and "1" is the single disk's worth of capacity used for parity, or redundancy overhead). So, as the number of disks in the array grows, the usable storage capacity percentage increases in relation to redundancy (parity) information.

Warm swap
The ability to remove and replace a disk drive while the power is on. All bus activity must be paused (usually done through a utility within the array management software) to maintain data integrity during removal or replacement. Typically used when hot swap is not supported by the server or storage enclosure drive tray. (See also *Hot spare and Hot swap.)*

RAID Level Comparison

Each RAID level has inherent cost, performance, and availability (fault-tolerance) characteristics designed to meet different storage needs. Most RAID levels can effectively satisfy only one or two of these criteria. For example, RAID 0/1 offers the highest performance and availability but also has the highest implementation cost. However, RAID 5 is the exception, providing the best overall balance of cost, performance, and availability for most servers.

The table on the next page shows the relative advantages and disadvantages of each RAID level.

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RAID Level Comparison

RAID Level	Minimum # of Drives	Description	Strengths	Weaknesses
RAID 0	2	Data striping without redundancy	Highest performance	No data protection
RAID 1	2	Disk mirroring	Very high performance; Very high data protection; Very minimal penalty on write performance	High redundancy cost overhead; Because all data is duplicated, twice the storage capacity is required
RAID 2	Not used in LAN environments	No practical use	Previously used for RAM error correction (known as Hamming code) and in disk drives before the use of embedded error correction	No practical use; Same performance can be achieved by RAID 3 at lower cost
RAID 3	3	Byte-level data striping with dedicated parity drive	Excellent performance for large, sequential data requests	Not well-suited for transaction-oriented network applications; Single parity drive does not support multiple, simultaneous read and write requests
RAID 4	3 (not widely used)	Block-level data striping with dedicated parity drive	Data striping supports multiple simultaneous read requests	Write requests suffer from same single parity-drive bottleneck as RAID 3; RAID 5 offers equal data protection and better performance at same cost
RAID 5	3	Block-level data striping with distributed parity	Best cost/performance for transaction-oriented networks; Very high performance, very high data protection; Supports multiple simultaneous reads and writes; Can also be optimized for large, sequential requests	Write performance is slower than RAID 0 or RAID 1
RAID 0/1	4	Combination of RAID 0 (data striping) and RAID 1 (mirroring)	Highest performance; Highest data protection (can tolerate multiple drive failures)	High redundancy cost overhead; Because all data is duplicated, twice the storage capacity is required; Requires minimum of four drives

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(AC) = task done in Array*Config*

(NW) = task done in NetWare version of CI/O Array Management Software

(NT) = task done in Windows version of CI/O Array Management Software

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