Using a Network Server PCI RAID Disk Array Card

Installing the card, and configuring and administering disk arrays

Apple Computer, Inc.

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Communications regulation information

FCC statement

This equipment has been tested and found to comply with the limits for a Class B digital device in accordance with the specifications in Part 15 of FCC rules. See instructions if interference to radio or television reception is suspected.

Radio and television interference

The equipment described in this manual generates, uses, and can radiate radio-frequency energy. If it is not installed and used properly—that is, in strict accordance with Apple's instructions—it may cause interference with radio and television reception.

This equipment has been tested and found to comply with the limits for a Class B digital device in accordance with the specifications in Part 15 of FCC rules. These specifications are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation.

You can determine whether your computer system is causing interference by turning it off. If the interference stops, it was probably caused by the computer or one of the peripheral devices.

If your computer system does cause interference to radio or television reception, try to correct the interference by using one or more of the following measures:

- Turn the television or radio antenna until the interference stops.
- Move the computer to one side or the other of the television or radio.
- Move the computer farther away from the television or radio.
- Plug the computer into an outlet that is on a different circuit from the television or radio. (That is, make certain the computer and the television or radio are on circuits controlled by different circuit breakers or fuses.)

If necessary, consult an Apple-authorized service provider or Apple. See the service and support information that came with your Apple product. Or, consult an experienced radio/television technician for additional suggestions.

IMPORTANT Changes or modifications to this product not authorized by Apple Computer, Inc., could void the FCC Certification and negate your authority to operate the product.

This product was tested for FCC compliance under conditions that included the use of Apple peripheral devices and Apple shielded cables and connectors between system components. It is important that you use Apple peripheral devices and shielded cables and connectors between system components to reduce the possibility of causing interference to radios, television sets, and other electronic devices. You can obtain Apple peripheral devices and the proper shielded cables and connectors through an Apple-authorized dealer. For non-Apple peripheral devices, contact the manufacturer or dealer for assistance.

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About This Guide

The guide gives a basic orientation to what RAID technology is and what it can do, coupled with guidelines for designing a RAID configuration that works for you. It then provides all the information you'll need to set up, configure, and administer the Network Server PCI RAID Disk Array Card and its associated software.

What you need to know

This guide is aimed at Network Server administrators, and it assumes the same level of knowledge that is required for general Network Server administration. You need not know AIX to get RAID up and running, but you will need a basic understanding of AIX and AIXwindows to use the product. Before proceeding with the tasks covered in this guide, you should familiarize yourself with the material covered in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server,* especially Chapter 2, "Installing AIX on Your Network Server"; Chapter 3, "System Startup, Logging In, Shutting Down, and Rebooting"; Chapter 4, "Using AIXwindows and the Common Desktop Environment"; and Chapter 8, "Managing File Storage with the Disk Management Utility." You should also have a good understanding of the Network Server hardware, as covered in *Setting Up the Network Server.* Both of these manuals are in the Network Server accessory kit.

How to use this guide

Chapters 1–3 prepare you for and lead you through the basic tasks of setting up and configuring your disk array. Although the administrative tasks covered in Chapters 4 and 5 may not be needed right away, it is a good idea to read these chapters carefully before putting the RAID system into operation. This allows you to plan an administrative strategy that includes regular monitoring and to put that strategy into effect immediately.

Onscreen help

The Network Server PCI RAID Disk Array Configuration Utility and Diagnostics Utility display onscreen messages detailing steps and options within each procedure. Also, an onscreen version of Chapter 5, “Administering the Disk Array With the Disk Array Manager,” can be accessed from the Help menu any time the Disk Array Manager is running.

1 Planning for RAID

A RAID controller is a powerful tool for protecting data or speeding up disk read/write operations, or both. This chapter orients you to the Network Server PCI RAID Disk Array hardware and software. It then focuses on designing a RAID approach that is right for you.

Product overview

The Network Server PCI RAID Disk Array solution combines hardware and software to support RAID levels 0, 1, 5, 6 (also known as 0+1), and 7. These levels are explained in detail in "Choosing a RAID Level," later in this chapter.

RAID hardware

Each Network Server PCI RAID Disk Array Card is a full-featured RAID controller. Each controller includes its own central processing unit (CPU) so as to maximize performance and flexibility within a disk array while minimizing dependence on the Network Server CPU.

Both dynamic random-access memory (DRAM) and non-volatile random-access memory (NVRAM) are supported. DRAM provides disk caching for increased performance, particularly in writes. NVRAM stores the current configuration, including information on hardware states.

Firmware is stored in extended erasable programmable read-only memory (EEPROM). This allows firmware to be upgraded without changing the ROM chip set.

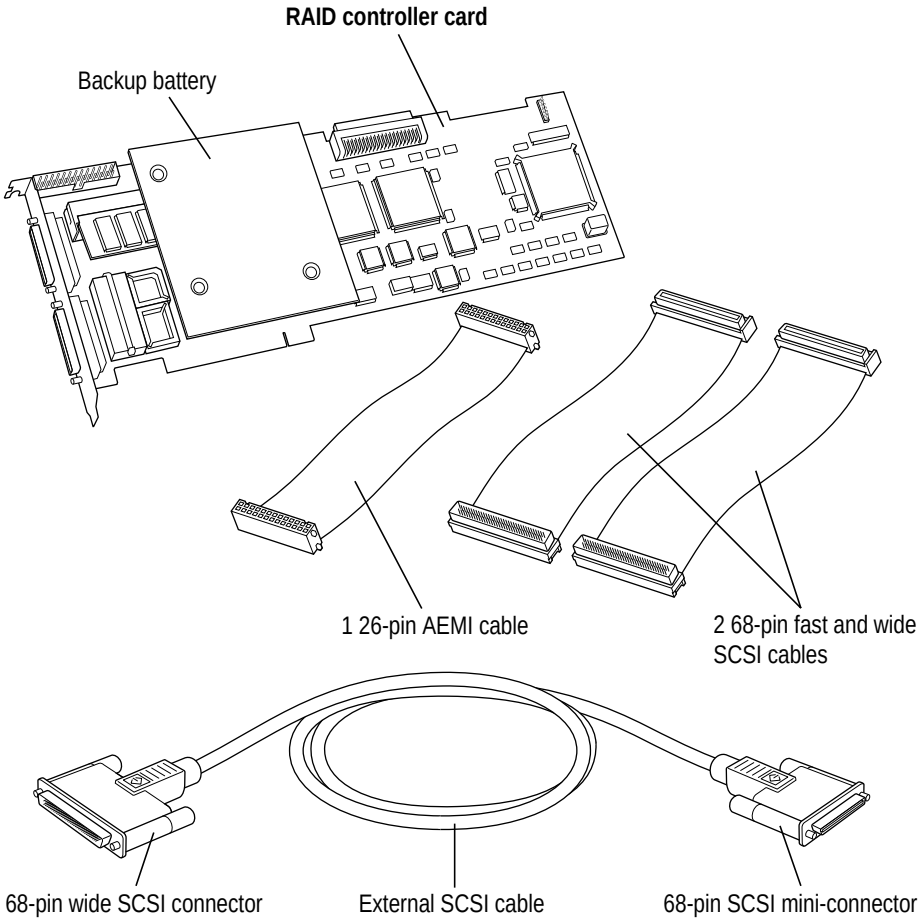
The controller supports two fast and wide SCSI channels, labeled 0 and 1. These channels can be used with SCSI II hard disks, whether fast and wide, or fast or wide, and with SCSI I disks.

Note: Because the performance of SCSI disks varies considerably, from fast and wide SCSI II on the high end, to ordinary SCSI I disks on the low end, it makes sense to use disks of the same type whenever possible.

Two 68-pin SCSI cables are provided for connection to the Network Server's internal disk array. Each card can also be connected to one or two external disk arrays utilizing a Network Server External SCSI Cable for RAID Card, available from your Apple-authorized Network Server dealer. If internal and external arrays are connected, they become one large array, distributed over the Network Server's two independent SCSI channels.

All Network Server PCI RAID Disk Array Cards include a battery backup enclosure, with a battery, for the protection of the DRAM cache. The controller supports the Array Enclosure Management Interface (AEMI). AEMI regulates the indicator lights on disks in the internal drive bays of the Network Server. AEMI also initiates automatic rebuilding when a disk is damaged. Rebuilding is discussed in detail in both Chapter 4 and Chapter 5. AEMI requires connection of a 26-pin AEMI cable, included in your RAID accessory kit.

Full card specifications can be found in Appendix A, “Specifications.” The RAID hardware is displayed in the illustration that follows.



RAID software

The Network Server PCI RAID Disk Array Card comes with software for configuration, monitoring, and diagnostics.

Open Firmware is the ROM-based code that controls the Network Server when an operating system has not been installed or is not functioning. Two Open Firmware utilities are supplied on the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk included in your Network Server PCI RAID accessory kit:

- The Configuration Utility is used to configure, monitor, and administer the array when the operating system is not running.
- The Diagnostics Utility provides diagnostics for the card itself and for the disks in the array, again when the operating system is not running.

AIX is the operating system supplied with the Network Server. An AIXwindows utility is supplied on the *Network Server PCI RAID Disk Array Manager* CD-ROM disc, which is also included in your accessory kit:

- The Disk Array Manager is a graphical monitoring and administrative program that can be used while the array is in operation.

Adding additional arrays

You can install up to 4 Network Server PCI RAID Disk Array Cards, each supporting an array of up to 14 disks of any size, for a total of 56 disks. Each controller functions completely independently of all others.

Disk compatibility

You can include any hard disk that can be used with the Network Server in a RAID disk array. However, RAID treats all disks in an array as though they were of the same capacity as the smallest disk in the array. The wider the capacity gap, the more space is wasted. Use disks of identical capacity wherever possible.

Total capacity

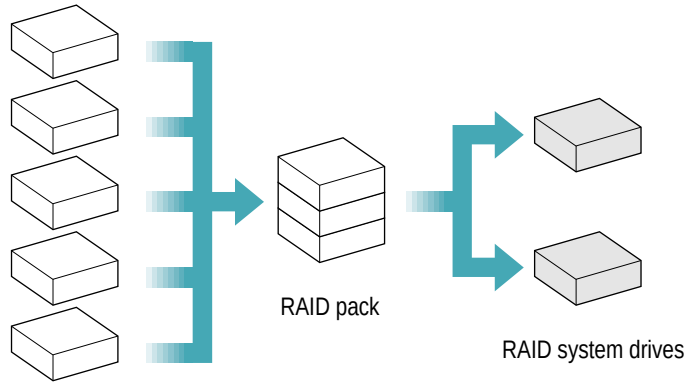
A maximum of 7 hard disks can be connected to each SCSI channel of the Disk Array Card, for a total maximum of 14 hard disks on two SCSI channels. Note that this total capacity is per controller. Adding additional Network Server PCI RAID Disk Array Cards permits you to support an additional 14 physical disks per card. With 4 controller cards, the physical maximum, up to 56 disks can be managed by RAID.

How the RAID controller coordinates the disk array

Each controller coordinates the disks in its array in order to optimize data availability, performance, and capacity. The specific structure is determined by the number of disks in the array and the particular configuration you determine. (Configuration is covered in Chapter 3, “Configuring the Disk Array.”)

Disks are first grouped into *packs*, also known as *drive groups*. Disks that are in an array but not assigned to a pack are on standby. Such disks are also known as *hot spares*. When a disk in a fault-tolerant array is damaged, a standby disk takes its place. Data from the damaged disk is automatically rebuilt onto the standby disk, with no interruption in operations.

System drives, also known as *logical drives*, are created from packs. A system drive can include a part of a pack, an entire pack, or up to four packs, provided each pack has the same number of hard disks. The illustration that follows shows the hierarchy in graphic form.



Non-disk SCSI devices (such as CD-ROM drives or tape drives) that are on a SCSI channel connected to a Network Server PCI RAID Card are automatically controlled by and accessed through the Disk Array Controller. They are not, however, grouped into the RAID hierarchy discussed above, and they do not count in the totals determining possible RAID levels.

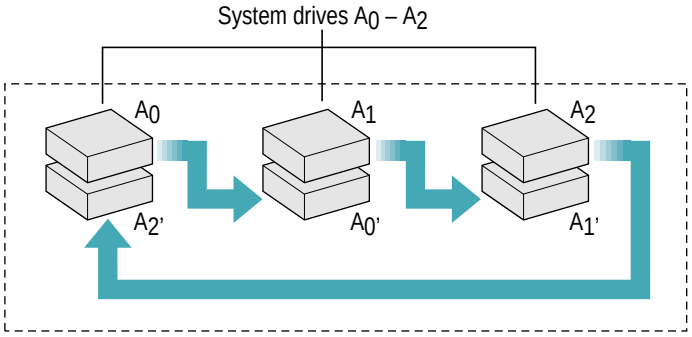
Pack structure

A controller can support up to eight packs, and each pack can contain up to eight disks. The RAID configuration utility identifies packs by letter (A through H) and further identifies the disks within a pack by number (0 through 7).

Note: Packs can be created with disks of varying sizes, but it is good practice to avoid this if possible. The capacity of such a pack equals the product of the number of disks in the pack times the capacity of the smallest disk.

System drive structure

A system drive can include all or part of a single pack, or all or part of a combined pack (a group of up to four packs), provided each pack in the group has the same number of hard disks. The following illustration shows a RAID configuration with three system drives created from a single pack containing three disks.



Pack A (3 drives)

You assign RAID levels, discussed in detail later in this chapter, to system drives. The number of disks in the pack on which the system drive is based determines which RAID levels are available. (When more than one pack is included in the system drive, the number of disks in any one pack determines the RAID levels that can be assigned to the system drive.) If the size of the pack allows a choice of RAID levels, you choose one level (only) for the system drive.

You can create up to eight system drives in each array, and each system drive can contain up to four packs or portions of packs.

About hot spares and hot swapping

RAID classifies any disk not included in a pack as a standby disk, also known as a hot spare. In the event of a disk failure, data from the failed disk is automatically rebuilt on the standby disk. With hot swapping, on the other hand, the administrator removes the damaged disk and replaces it with another disk of equal or greater capacity. The procedure is called hot swapping because the server stays on while the disk exchange is made.

If the Automatic Enclosure Management Interface (AEMI) is enabled, as it always should be with arrays that include the internal disks in the Network Server, hot swapped disks automatically begin rebuilding immediately after they are installed. If AEMI is not enabled or is not supported, as in some solely external arrays, rebuilding must be initiated manually. For details on the hot swapping procedure, see "Rebuilding on Replacement Disks" in both Chapter 4 and Chapter 5.

> **WARNING** Many, but not all, external arrays support hot swapping. Be sure to check your external array's specifications. Hot swapping on an array that does not support the feature can cause disk or system drive failure and data loss. Be sure to turn off the Network Server and the external array before swapping in a replacement disk.

Choosing and applying a RAID strategy

The Network Server PCI RAID Disk Array can increase performance or increase data availability, or both. Performance and availability are different for each RAID level. The disk capacity required for data redundancy also varies. The RAID levels you assign are limited by the number of disks you have available. Within that limitation, your choice should be based on your needs for capacity, performance, and data availability.

Profiling your array

Each array has a different access profile—a specific type and frequency of read and write activity that is performed over the course of time. A video server, for example, typically writes data infrequently but reads back often. The files, typically, are very large. This is far different from a general-purpose file server doing continual but small read-and-write operations. One RAID configuration can't serve both of these systems equally well. Identifying the data access profile will help you determine a strategy that provides the appropriate blend of capacity, availability, and performance.

Choosing a RAID level

The following table lists RAID levels supported by the Network Server PCI RAID Disk Array and highlights the performance characteristics, as well as the fault tolerance (ability to maintain data integrity despite disk failure), of each one.

Supported RAID Levels

RAID Level	Fault Tolerance	Description
0	No	Data is striped across all disks in the array, resulting in very high performance. No redundancy is provided. May be used for system drives containing a pack or packs of two to eight disks each.
1	Yes	Disks are paired and mirrored. All data is 100% duplicated on an equivalent disk. Safety is maximized, while capacity is cut by 50%. Access speed is equivalent to an individual disk under normal circumstances, but will be lower during rebuilding. May be used only for system drives containing a pack or packs of two disks each.
5	Yes	Data is striped across several physical disks. Parity protection is used for data redundancy, at a fraction of the disk overhead mirroring requires. Disks read and write independently, so performance is excellent, although lower than with RAID 0. The controller can recreate lost data on a replacement disk without interrupting access by users, and rebuilding can be manual or automatic. May be used for system drives containing a pack or packs of three to eight disks each.
6	Yes	Also known as RAID 0+1. Data is both striped and mirrored. Both performance and fault tolerance are optimized, but disk capacity is reduced by half, as with RAID 1. May be used for system drives containing a pack or packs of three to eight disks each.
7	No	Also known as “Just a Bunch of Drives,” or JBOD. The controller treats each disk as a stand-alone disk, or, alternatively, disks may be spanned and seen as a single large disk. A high-performance cache is provided, but there is no striping and no data redundancy. May be used for system drives containing a pack or packs of one disk each.

Choosing a RAID level to maximize storage capacity

The table that follows shows the the effective capacity (available storage capacity minus overhead) for each RAID level. Note that N equals the number of disks in the array, while X equals the available capacity of a single disk (the smallest disk). Because the RAID software sizes all disks within a pack according to the size of a smallest disk, X may not equal the physical capacity of some included disks. The available capacity will, however, be the same for all disks.

Raid Levels and Effective Capacity

RAID Level	Effective Capacity
0	X*N
1	(X*N)/2
5	X*(N-1)
6	(X*N)/2
7	X*N

As you can see, the greatest capacities are provided by RAID levels 0 and 7, with the entire capacity of all disks being used. Unfortunately, with these two solutions, there is no fault tolerance.

RAID 5 gives the next best capacity. RAID 1 and RAID 6 have the greatest capacity loss, with 50% of drive space devoted to mirroring.

Choosing a RAID level to maximize data availability

The table that follows shows the type of fault tolerance offered by each RAID level. Fault tolerance determines the data availability of an array.

Raid Levels and Fault Tolerance

RAID Level	Fault Tolerance
0	No fault tolerance.
1	Mirrored fault tolerance. Data is written to one disk, and then the same data is written to another disk. If either disks fails, the other one in the pair is automatically used to store and retrieve the data.
5	Striped fault tolerance. Data and parity are striped across a set of three or more disks. If any of the disks fail, the data and parity information from the failed disk is computed using information from the remaining disks.
6	Mirrored and striped fault tolerance. Data and parity information is striped across several disks, and written to a mirroring set of disks. This arrangement can survive several disk failures and continue to operate.
7	No fault tolerance.

Increasing availability with standby disks Using standby (hot spare) disks, discussed earlier in this chapter, can further improve the availability of all the fault-tolerant RAID levels. A standby disk is on, but idle, during normal array operation. If a failure occurs on a disk in a fault-tolerant set, the standby disk takes over for the failed disk, and the array continues to function in a fully fault-tolerant mode after it completes its automatic rebuild cycle. This means that the array can suffer a second disk failure and continue to function before any disks need be replaced.

Increasing availability with battery backup RAID maintains a disk cache in DRAM to increase the performance of data retrieval and storage. The controller uses this memory to store disk writes. In write back (WB) mode, the controller reports to the operating system that a write is complete as soon as the controller receives the data. This improves performance, but exposes you to data loss if a system crash or power failure occurs before the data in the cache is written to disk.

The Network Server PCI RAID Disk Array Card includes a battery backup for cache memory that can prevent such data loss and thus add some measure of safety even to non-fault tolerant arrays. The battery backup retains the cache until normal operation resumes, up to the limit of battery life. If power is restored before the battery goes dead, the data in the cache can be written through to the array.

Choosing a RAID level to maximize performance

In general, striping increases performance, while availability overhead decreases it. Thus RAID O, in which data is striped but there is no redundancy, provides the fastest raw speed of any level. RAID 1, with no striping but the overhead of mirroring, is the slowest of the levels.

The RAID 5 solution

As the tables earlier in this section reveal, RAID 5 is the most versatile of the RAID levels. For most situations, it offers the best balance of capacity, performance, and safety, and it is available for arrays of three or more disks. In Chapter 3, “Configuring the Disk Array,” you will see that RAID 5 is the RAID level used with the Automatic Configuration option. If this works for your system, it can greatly simplify your analysis and preparation.

Coordinating RAID with AIX

The AIX operating system has powerful and sophisticated data management capabilities of its own. To get the most benefit from RAID, it’s essential to understand how AIX views and works with RAID system drives. This section provides basic information and specific suggestions. For full understanding, however, you should have a good grasp of AIX data management and the AIX Logical Volume Manager. Once you have completed your RAID configurations and installed AIX, you can access the complete documentation set through the InfoExplorer application. For information on using InfoExplorer, see Chapter 5 of *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.* For now, you may be able to access the documentation through an existing system, or you can ask your network administrator about the availability of printed documentation.

You should also familiarize yourself with the Disk Management Utility, which is Macintosh-based file storage management software included with AIX for the Apple Network Server. The Disk Management Utility is fully covered in Chapter 8 of *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

How AIX views system drives

A system drive may contain up to eight physical disks, but AIX treats a system drive as a single hard disk. The operating system can be installed on and booted from a system drive exactly as from a hard disk. AIX SCSI ID mapping and storage management are applied to RAID system drives exactly as they are to physical disks.

SCSI ID mapping

AIX views the RAID controller as a single SCSI II controller, even though it controls two separate SCSI II channels. A single controller is limited to 16 SCSI IDs. The RAID controller itself always takes ID 7, leaving 15 IDs free.

As the Network Server boots, SCSI IDs are mapped as follows:

IDs 0–6 Non-disk devices

ID 7 RAID controller

IDs 8–15 RAID System Drives

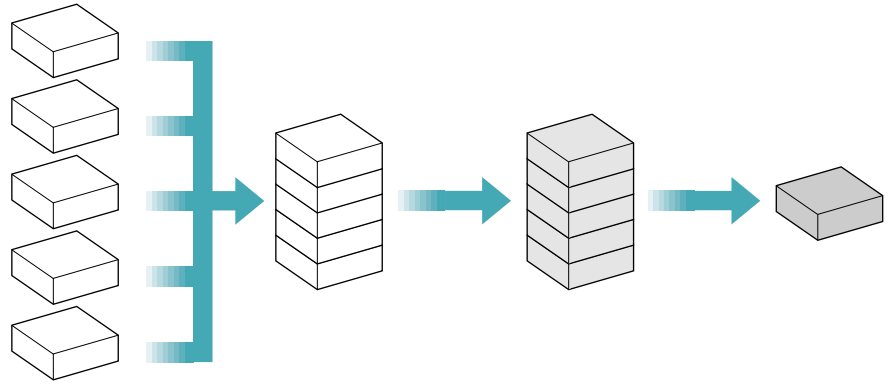
This mapping permits a maximum of seven non-disk devices and eight system drives to be connected to each RAID controller.

Note: The SCSI IDs for system drives (8–15) are logical IDs that do not refer to a particular physical device, but rather to a configuration.

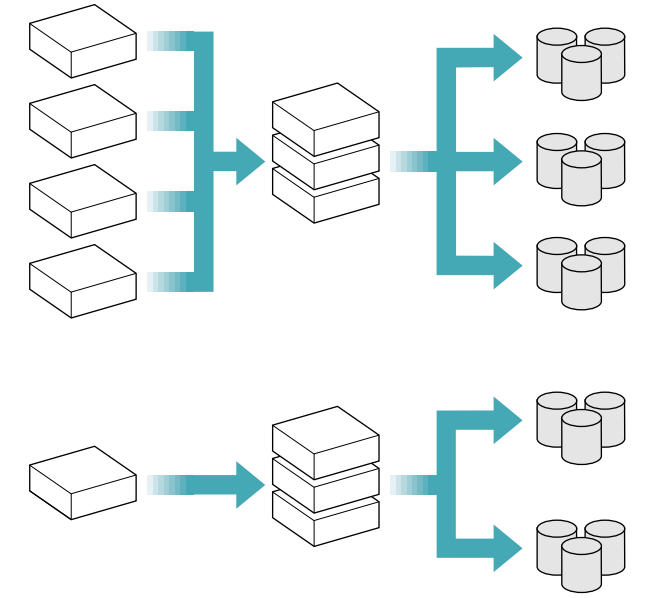
Within the confines of this device tree, AIX uses standard techniques of creating device nodes to access RAID system drives or non-disk devices. System drives are named `/dev/hdiskX`. CD drives are `/dev/cdX`, and tape drives `/dev/rmtX`. In each case X is the next available number. Once a system drive has been used with the AIX Logical Volume Manager, a unique physical ID is stored on it.

Coordinating RAID and AIX disk management

As discussed above, AIX views a RAID system drive as a hard disk, or *physical volume* in AIX terminology. Such physical volumes can be quite large. For example, assume that five 4 GB drives are combined into a pack. If a single system drive is created from this pack, AIX sees it as a 20 GB physical volume, minus any overhead or redundancy. The illustration that follows shows how the RAID configuration looks to AIX.

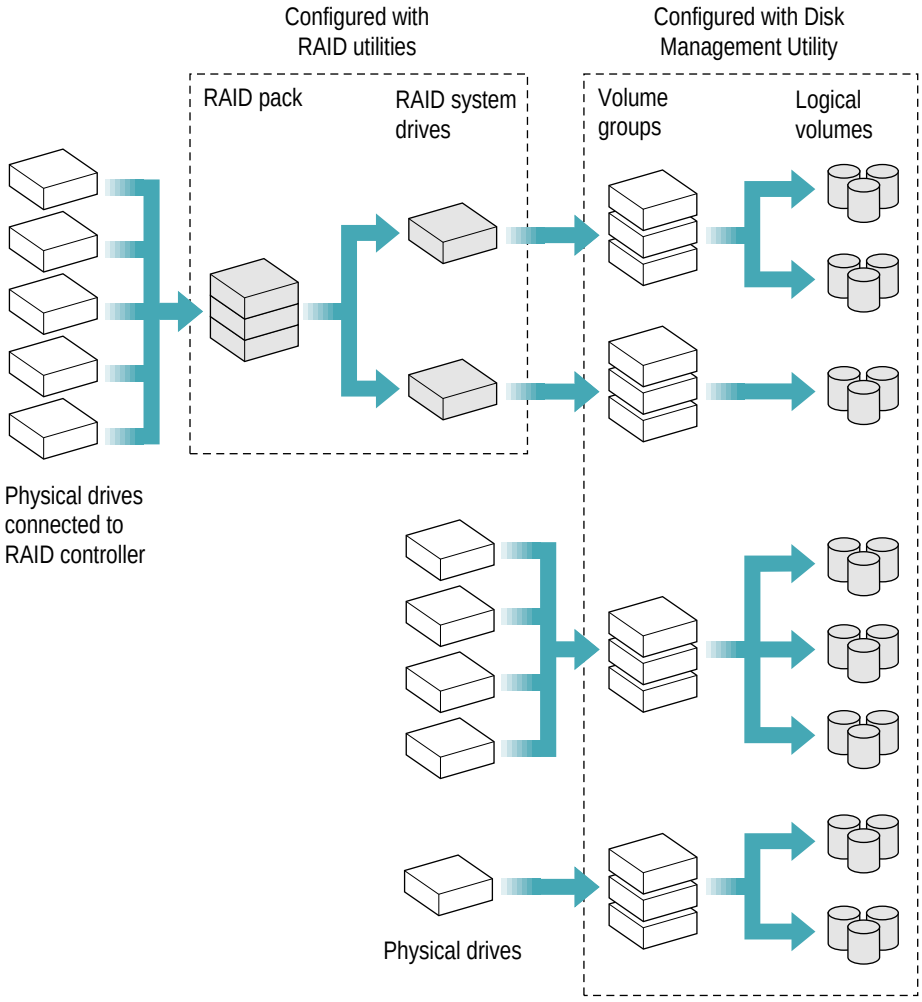


AIX enables a system administrator to create one or more *volume groups,* each of which is composed of up to 32 physical volumes, whether individual hard disks or RAID system drives. Each volume group can then be partitioned into one or more *logical volumes.* A logical volume can contain a JFS file system, a swap partition, a boot volume, or any other type of data. AIX 4.1 supports large file systems, so logical volumes of up to approximately 127 gigabytes (or 256 gigabytes if the logical partition size is increased from 4 MB to 16 MB) can be created. The illustration that follows shows an example of this hierarchy:



Configuring each RAID system drive into a separate volume group, with no other physical volumes included, allows for maximum simplicity and robustness. The overall configuration is relatively easy to understand and keep track of, and data redundancy is optimized. A file system that sits partly on non-redundant physical volumes and partly on a redundant RAID system drive defeats the purpose of RAID, because the failure of one non-redundant physical volume would bring down the file system. The illustration that follows contrasts volume groups created from RAID system drives with volume groups created directly from hard disks.

IMPORTANT Increasing the size of a system drive is complex and usually requires extensive data backup and restoration. Be sure to create a system drive that is large enough to accommodate future growth.



IMPORTANT The AIX Logical Volume Manager itself supports either striping (RAID 0) or mirroring (RAID 1) of logical volumes, although not both at the same time. Do not use the Logical Volume Manager to apply RAID levels to a logical volume formed from a RAID system drive.

2 Installing the Network Server PCI RAID Disk Array Card

This chapter shows you how to get your system ready for card installation, how to set jumpers and termination on the card, how to install the card, and, finally, how to connect the card to external arrays.

Backing up

RAID configuration, covered in Chapter 3, “Configuring the Disk Array,” erases all data on all hard disks in the array. If you are configuring a disk array which is already in use, you should back up the operating system (OS) and all data before installing the card. After configuration is complete, you can restore data and software on all configured disks.

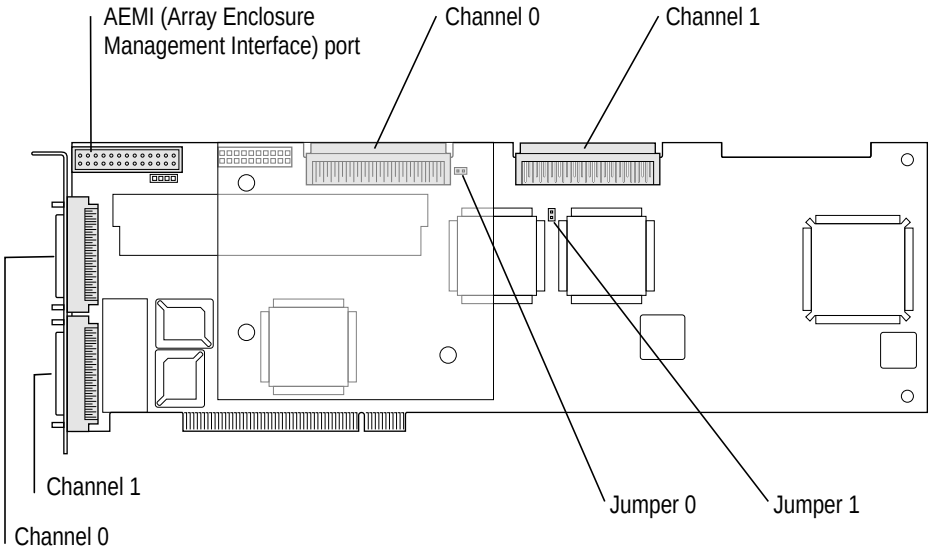
If you are planning to configure only a new external disk array that you are adding to an operational system, you probably won’t need to reinstall the OS or restore data. For safety reasons, though, you should still back up.

For complete information on backing up the AIX root volume group and installing AIX, see Chapter 2,“Installing AIX on the Network Server,” in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.* For information on backing up other volume groups, see the documentation supplied with your backup utility.

Preparing and installing the card

The Network Server PCI RAID Disk Array Card is, as shipped from the factory, fully prepared for use with the Network Server's internal hard disks. You may, however, need to adjust termination if you are adding external arrays.

The card's layout and the location of the cable connectors are shown in the next illustration:



IMPORTANT Before proceeding, familiarize yourself with the section on installing PCI cards in Chapter 2, "Installing Internal Server Components," in *Setting Up the Network Server.* Be sure to follow all procedures for handling and installing the card carefully and correctly, so as not to damage either the card or the computer.

Setting termination

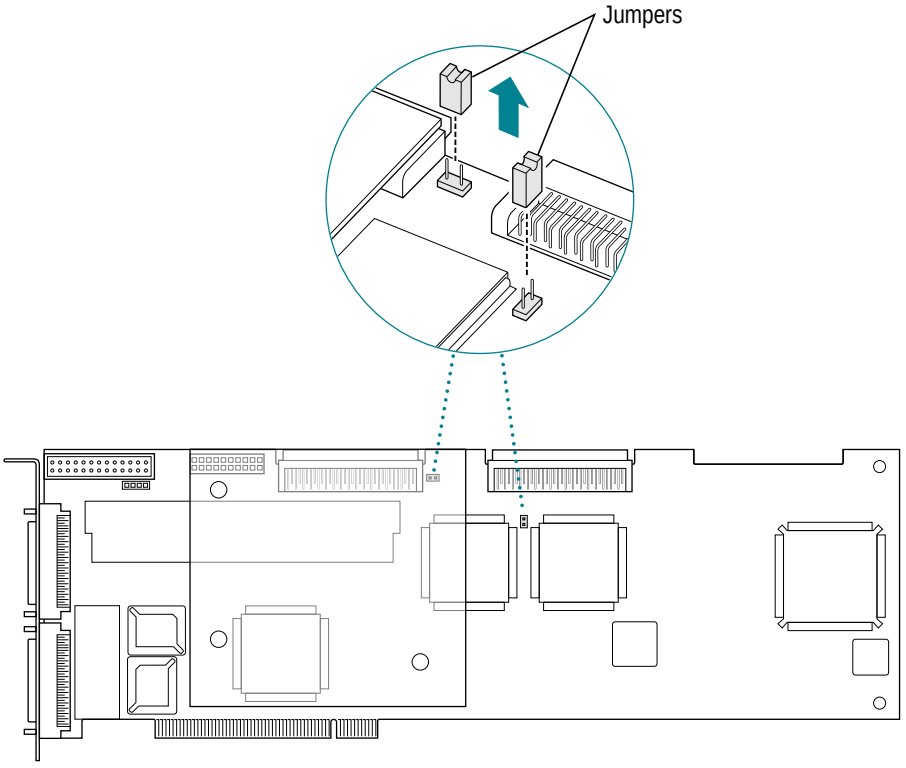
For proper operation, a SCSI channel must be terminated at both ends. The Network Server itself, which is always at one end of the chain when the controller is attached to the internal disk array, provides termination on both channels. Termination is also enabled on both channels at the RAID card. Two jumpers, labeled Jumper 0 and Jumper 1 in the illustration at the beginning of this section, which control termination on their respective internal SCSI channels, are set to on—termination enabled—at the factory. Therefore, if you are connecting the RAID card only to the internal array, you need do nothing more for proper termination.

Likewise, the card itself is properly terminated if your RAID configuration includes external arrays only, and not the Network Server's internal disks. In this instance, the SCSI chain runs from the card to the last disk in the external array. If necessary, add a terminator to the last device on each SCSI channel to terminate that end of the chain.

The situation changes if one or two external arrays are integrated with the internal disks to form a larger array. Termination is now in the middle and at one end of the SCSI chain, instead of at both ends as it should be. To correct the situation, simply remove the appropriate jumper or jumpers, as shown in the next illustration, and, if necessary, add a terminator to the last device on each SCSI channel in the external array.

Store the jumpers in a safe place after removal, or put them back on the card, making sure that they cover one jumper pin only, instead of the two that are needed to initiate termination.

Note: The next illustration shows both jumpers being removed, as is necessary when you are connecting an external array to both Channel 0 and Channel 1. If you are connecting one external array only, be sure that the jumper you remove matches the channel to which you are connecting. The labels on the card itself may vary, but the jumper location won't. Using the view given in the illustration, the Channel 0 jumper is always to the right of the Channel 0 connector. The Channel 1 jumper is always behind the Channel 1 connector.



Installing the card

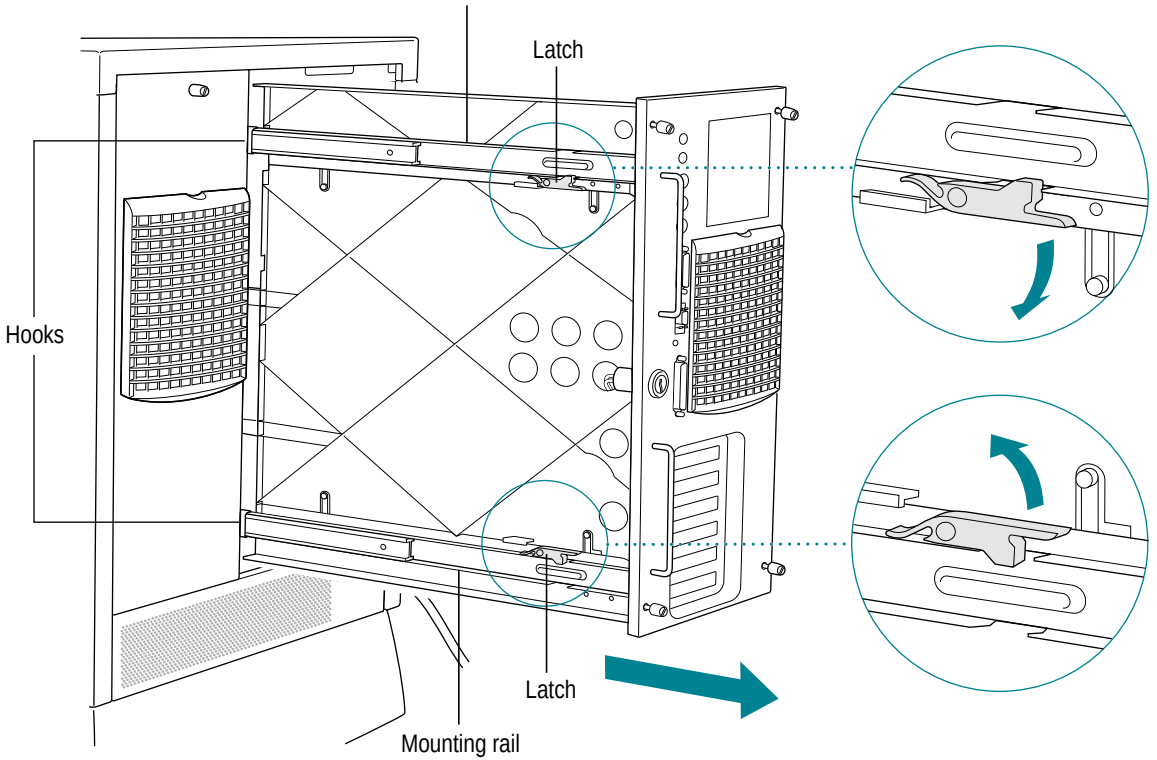
The RAID card fits quite snugly into the Network Server. Because of this the card installation procedure is somewhat different from the standard method covered in *Setting Up the Network Server.* To install the card, follow the instructions in this section.

Note: In many instances, the RAID card will already have been installed by your Network Server dealer. If not, and if you do not want to install the card or cards yourself, contact your dealer to arrange to have the work done for you.

1 **Remove the logic module from the Network Server.**

Although it is possible to install the RAID card without completely removing the logic module, the installation process is much easier if the module is removed. To remove the logic module, follow these instructions:

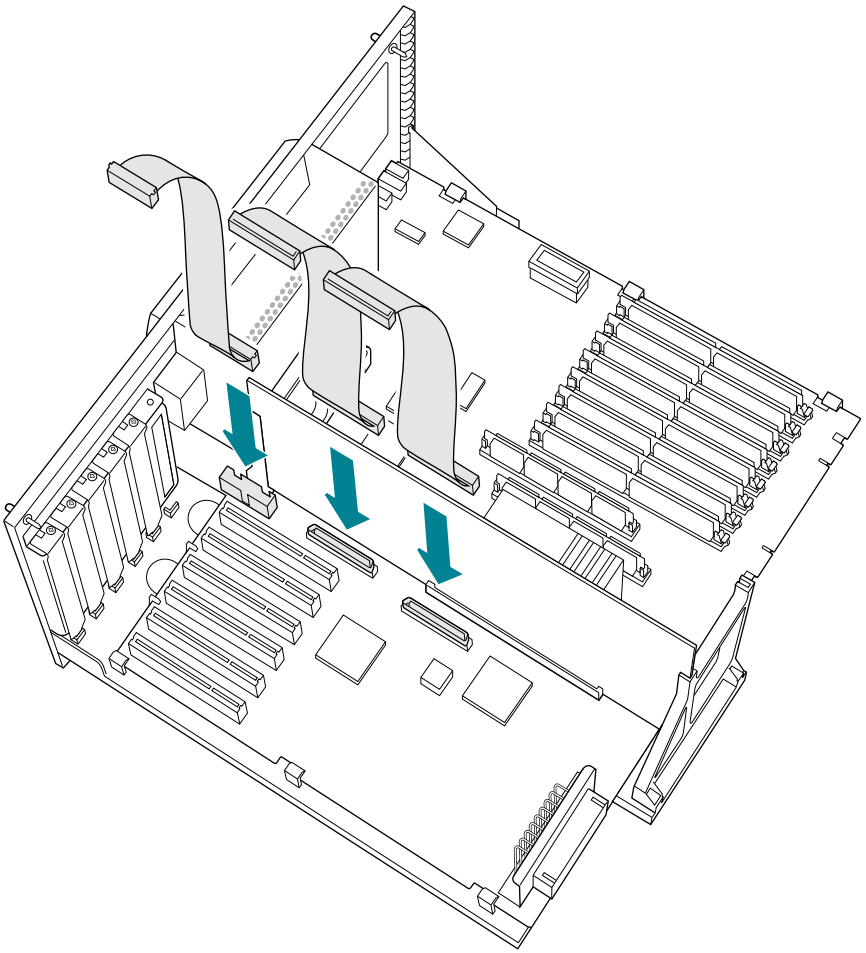
1. Shut down the Network Server.
2. Remove all cables, including the power cord, from the back of the server.
3. Turn the key at the rear of the server to the unlocked position.
4. Loosen the thumb screws.
5. Pull the logic module out a few inches.
6. While holding the logic module by one handle, as shown in the next illustration, release the black latches on the upper and lower mounting rails.
7. While continuing to support the logic module by its handle, first release the upper mounting rail and then the lower mounting rail.
8. Pull the logic module out and place it on an antistatic mat.



2 Attach the RAID card cables to the motherboard.

Two SCSI cables and one Array Enclosure Management Interface (AEMI) cable come with the Network Server PCI RAID Disk Array Card. All three must be installed for RAID systems utilizing the Network Server's internal drives.

It is much easier to connect all cables to the motherboard before rather than after installing the card. All cables have the same connectors at both ends. Be sure to install the AEMI cable with the slotted side facing down. The SCSI cables will only fit with the narrow edge of the connector facing down. The correct cable layout is shown in the next illustration:



3 **Remove the cover plates from all expansion slots in which you plan to install cards.**

Put the screws aside. You will reattach them at the end of this procedure to hold the cards firmly in position. Put the cover plates away for safekeeping.

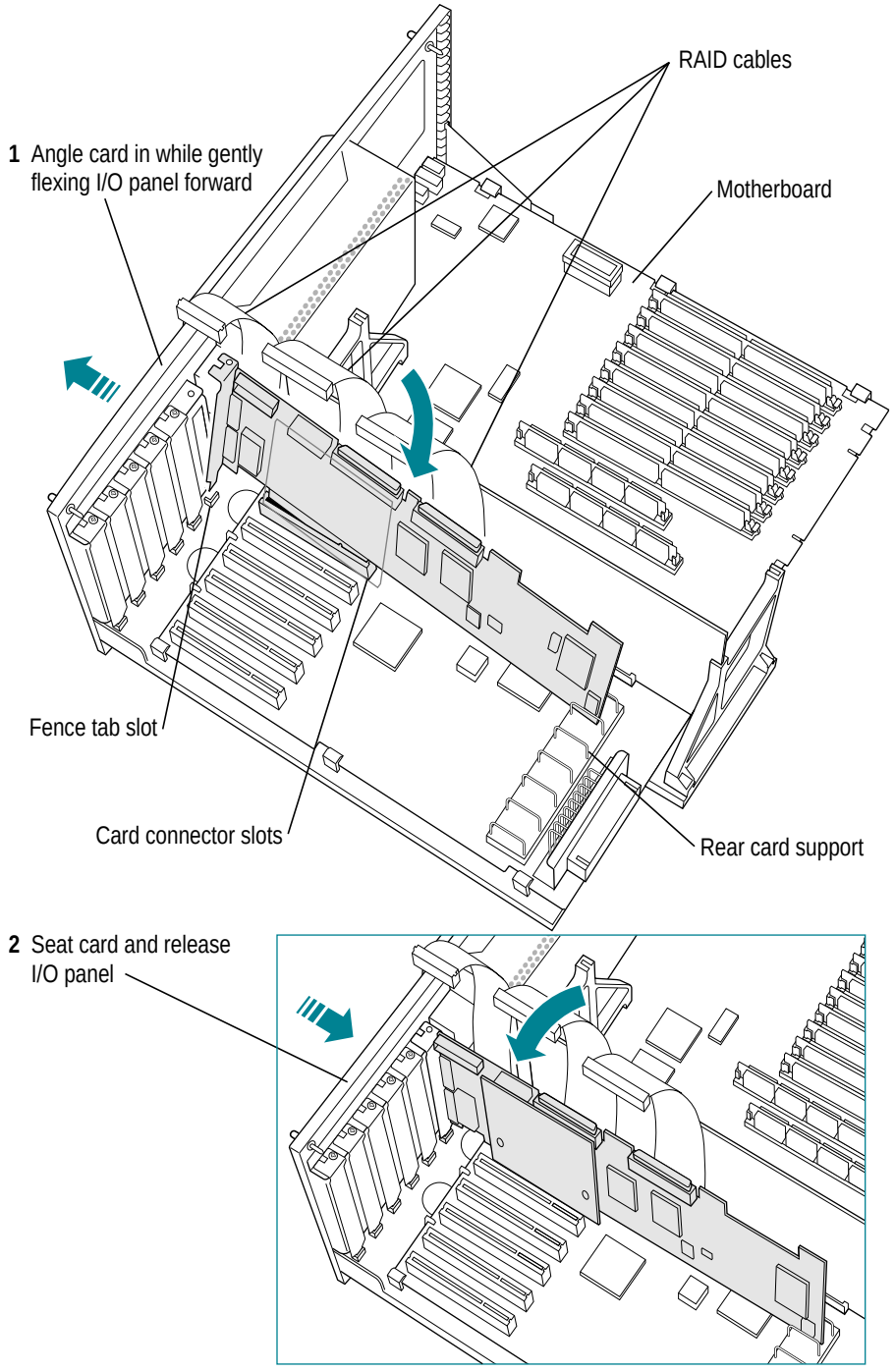
4 **Install a card.**

If you are installing a card to be used with the Network Server's internal drives, and, therefore, to be connected to the internal cables discussed earlier in this section, the card must go into slot one. Cards to be connected to external arrays only may go into any slot and do not require internal cabling. The same basic installation procedure applies in both instances.

1. With the card slanting upward, place the lower rear corner of the card in the card support, and the lower rear corner of the gold-colored PCI connector into its slot.
2. Gently pull the top of the I/O panel forward.

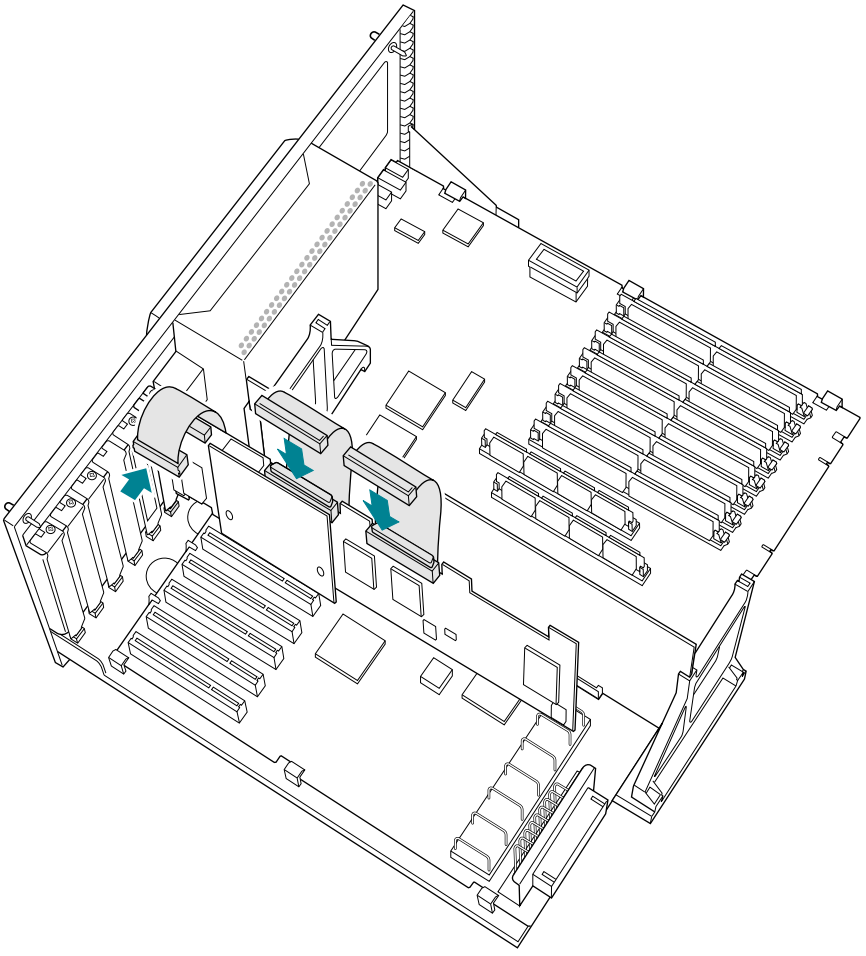
   It flexes easily.
3. With the I/O panel flexed forward, push down on the card until both the connector and the tab at the end of the card fence are seated firmly.

Use the next illustration as a guide:


RAID cables
1 Angle card in while gently flexing I/O panel forward
Motherboard
Fence tab slot
Card connector slots
Rear card support
2 Seat card and release I/O panel

5 **Attach the SCSI and AEMI cables to the card.**

The cables, which you have already attached to the motherboard, attach to their corresponding slots on the card, as shown in the next illustration:



6 **Install additional cards as necessary.**

You can install up to four Network Server PCI RAID Disk Array cards. The controllers operate completely independently of each other. Cards located in any slot other than slot one can be used only with external disk arrays and do not require either an AEMI cable or internal SCSI cables.

7 Replace the screws on the card fences.

Don't replace the screws until all cards are installed. The I/O panel will not flex with the screws in.

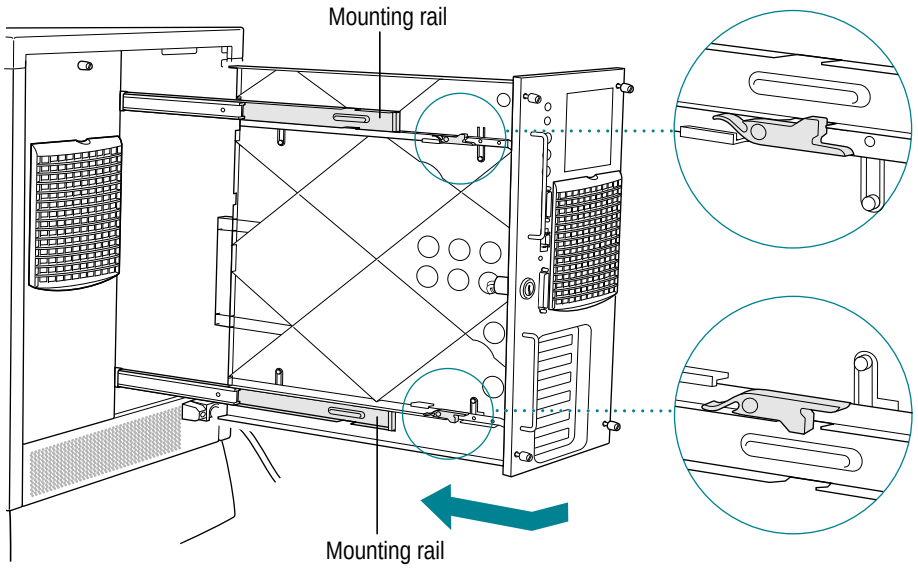
Note: If you install additional cards at a later date, you will need to remove the screws from all installed cards before doing so.

8 Replace the logic module

Use the following procedure. Refer to the next illustration to orient yourself.

1. Keeping the rail forward of the black latch, and holding the logic module at a slight upward angle, seat the lower mounting rail of the module on the lower slide.
2. Moving the module to a full upright position, and again keeping the rail forward of the black latch, seat the upper mounting rail on the upper slide.
3. Slide the rails back to engage the black latches on both the upper and lower mounting rails.
4. Slide the logic module into the Network Server, making sure that the slides engage the hooks on the upper and lower mounting rails.

9 Reattach all cables and the power cord, and turn the key to the locked position.



Attaching external disk arrays

You can connect two external arrays to the back connectors of any RAID card installed in the Network Server. Before connecting an external array, make sure that the jumpers have been set correctly, as discussed in "Setting Termination," earlier in this chapter. Connect the array with a Network Server External SCSI Cable for RAID Card, available from your Apple-authorized Network Server dealer. The part number is M4031.

Setting SCSI IDs on external arrays

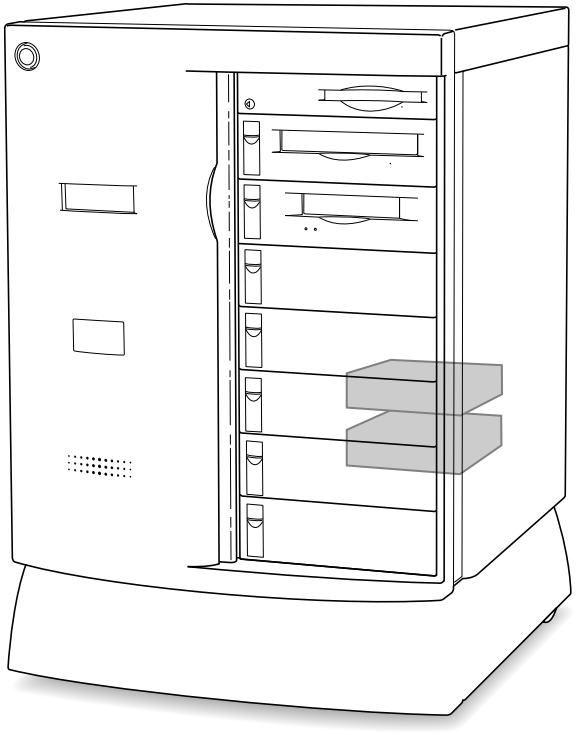
If you are connecting external arrays to the same SCSI channels as are used for the Network Server's internal array, you need to assign SCSI IDs carefully so as to avoid conflicts. The following guidelines should help:

- On Channel 0, SCSI IDs 0–3 are assigned to front drive bays on all models of the Network Server.
- On Channel 1, SCSI IDs 4–6 are assigned to front drive bays on all models of the Network Server.
- On Channel 1, SCSI IDs 0 and 1 are assigned to back drive bays on the Network Server 700/150.
- SCSI ID 7 on both channels is reserved for the Network Server PCI RAID Disk Array Controller.

Thus the following SCSI IDs are available for assignment to devices on an external array:

- On Channel 0, SCSI IDs 4, 5, and 6 are available.
- On Channel 1, SCSI IDs 0, 1, 2, and 3 are available on the Network Server 500/132. SCSI IDs 2 and 3 are available on the Network Server 700/150.

Note that while you can also use the SCSI ID of any drive bay that is currently vacant, doing so is not recommended. If you install a drive in that bay in the future, you may have to change some or all assigned SCSI numbers to remove conflicts that develop. The next illustration shows how ID numbers map to the Network Server drive bays:



The SCSI situation is simplified for cards connected to only external arrays. You can assign any SCSI ID from 0 to 6 to devices connected to each of those cards; SCSI ID 7 is always reserved for the RAID controller.

IMPORTANT Although disk drives on separate channels can have the same SCSI ID, non-disk devices, such as CD-ROM drives or tape drives, must have IDs that are unique across channels. Thus if you install a CD-ROM drive at ID 0 on Channel 0, you cannot use ID 0 on Channel 1.

3 Configuring the Disk Array

You configure and initialize a disk array using the Network Server PCI RAID Disk Array Configuration Utility. Although the Configuration Utility also provides management features, these are covered in Chapter 4, “Administering the Disk Array With the Configuration and Diagnostics Utilities.” This chapter limits itself to configuration.

> **WARNING** If you use the Network Server PCI RAID Disk Array Configuration Utility incorrectly, you may cause errors that are difficult to correct. We recommend that you restrict use of this utility to administrator-level personnel, and that all directions be followed carefully.

Copying the utilities

The configuration and diagnostics utilities are supplied on the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk, included in your RAID accessory kit. Before beginning configuration, you should make a copy of the floppy disk and store the original in a safe place. To copy the utilities, follow these instructions:

1. **Insert the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk into the floppy disk drive of a computer running the Mac OS.**

   An icon representing the floppy disk appears on the screen.

2. **Double-click the disk icon to open it.**

   The icons for the Configuration Utility and the Diagnostics Utility appear. The files are named *dacconf.ns* and *dacdiag.ns.*

   Note: You will also see an icon for the firmware upgrade utility. You do not need to use this utility at this time.

3. **Drag the icons for the Configuration Utility and Diagnostics Utility to your hard disk icon.**

   A message tells you that the files are being copied.

4. **Eject the disk by dragging its icon to the Trash.**

5. **Insert a blank, freshly-formatted Mac OS floppy disk.**

6. **Drag the icons for the Configuration Utility and the Diagnostics Utilities to the blank floppy disk.**

   A message tells you that the files are being copied.

7. **Name and label the disk and store it for safekeeping.**

   If you need more information about copying, formatting, or naming, see the user's manual that came with your Mac OS computer.

Starting the Configuration Utility

The Network Server PCI RAID Disk Array Configuration Utility runs under Open Firmware, the ROM-based system that controls the computer before the operating system (OS) has been booted. The utility therefore can be, and preferably is, used before an OS has been installed. To launch the utility, follow these instructions:

1 **Make sure the key is in position for normal operation.**

This can be either upright or to the right.

2 **Invoke the Open Firmware prompt if it's not visible already.**

If no OS has been installed, the Open Firmware prompt appears automatically when the Network Server is turned on.

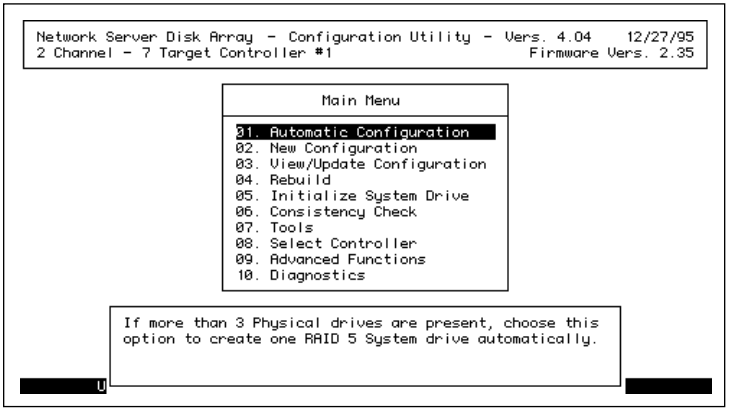
If AIX has been installed and is already running, you'll need to reboot the Network Server. At the AIX prompt, type `shutdown -r` (if users are connected) or `reboot` (if no users are connected), and press Return. Then, while the Network Server is rebooting, simultaneously press and hold down the *Option*, *Command*, *O*, and *F* keys until the Open Firmware prompt appears.

3 **Insert the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk.**

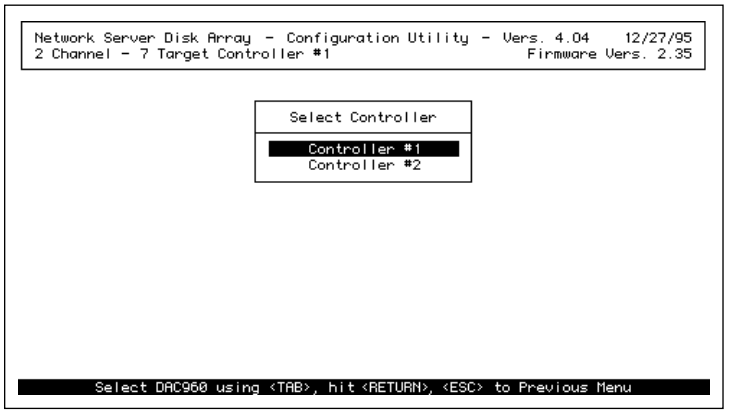
4 **At the Open Firmware prompt, type the following instruction exactly and press Return.**

```
boot fd:dacconf.ns
```

If you have one controller installed, the Main Menu appears:



If more than one controller is installed, the Select Controller screen appears:



If you have more than one controller, follow the procedure in the next section. If you have one controller, skip the next section.

Selecting a controller to configure

The Configuration Utility configures one controller at a time. You can specify which controllers, and in what order, to configure. In the preceding screen, you can see that the first controller on the list is automatically highlighted.

- **To select the highlighted controller, press Return.**
- **To select another controller, press and release the Tab key until your choice is highlighted and press Return.**

In either case, the Main Menu, shown in the preceding section, appears.

When you have finished configuring the first controller, you can proceed to configure additional controllers by the same method:

1. **Choose *Select Controller* from the Main Menu.**

   Tab to highlight Select Controller and press Return.

   The controller selection screen appears.

2. **Tab to highlight the controller you want to configure and press Return.**

   The Main Menu appears.

Checking hardware parameters and stripe size

Before proceeding with configuration, you should make sure that all hardware parameters are set properly for your needs. You should also think about the default stripe size (8K—which provides optimal random input and output performance in sequential throughput) and modify it if it's not what you need.

The hardware parameters are set at the factory to the settings most administrators want. Check, however, to be sure they're right for you.

Setting the stripe size should also be done before configuration, because changing it when the array is in operation causes data loss. (It can be done, but it requires you to fully back up and then restore your data.) Making the right choice requires a good understanding of how your array will be used. If you are unsure how to proceed, you can talk to other RAID administrators at your installation, or you can accept the default setting.

Checking hardware parameters

The following hardware parameters can be enabled or disabled for each Network Server PCI RAID Disk Array controller:

- Battery backup, which guards against data loss from the controller's cache memory.

  Battery backup is a feature of the Network Server PCI RAID Disk Array Card. It should always be enabled.

- Array Enclosure Management Interface (AEMI), which controls the indicator lights on disk drives in the Network Server enclosure. It also provides for automatic rebuilding of hot swapped disks, without going through either the Configuration Utility or the Disk Array Manager. If you are using the Network Server's internal disk array, AEMI should be enabled.

- StorageWorks Fault Management™, which is used exclusively by DEC computers, should be disabled for use with the Network Server. If left enabled, the indicator lights on the server's internal drives won't function.

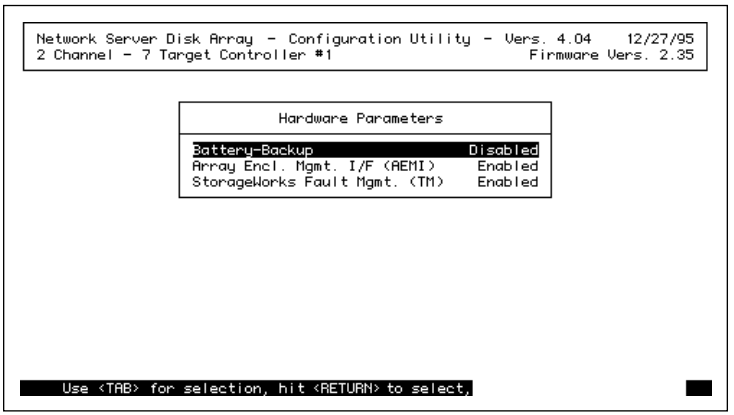
To check the state of these parameters, and to reset them if necessary, follow these instructions:

1 **In the Main Menu, tab to highlight Advanced Functions and press Return.**

The Edit/View Parameters menu appears.

2 **Tab to highlight Hardware Parameters and press Return.**

The Hardware Parameters menu appears:



3 **Tab to highlight the parameter you want to change and press Return.**

Pressing Return switches you back and forth between Enabled and Disabled.

4 **Repeat step 3 to change any additional parameters.**

5 **Press Escape.**

Your choices go into effect.

Setting stripe size

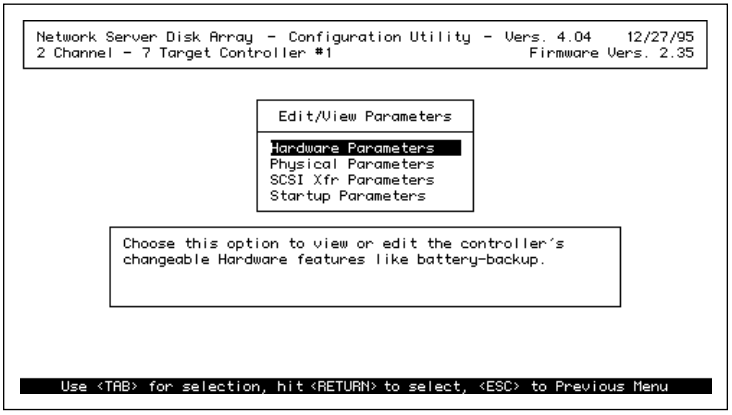
If your RAID level provides striping, each input/output (I/O) operation is striped across all disks in a system drive. Stripe size is the size in kilobytes of a single I/O operation. The default stripe size is 8K, which provides optimal random I/O performance but reduced performance in sequential throughput. Depending on your needs, you may want to increase the stripe size to 16K, 32K, or 64K.

Note: The controller uses the same stripe size for all system drives in the disk array. Therefore be sure the stripe size you choose is an improvement overall. If it's not a clear improvement, you may want to stick with the default.

To modify the stripe size, follow these instructions:

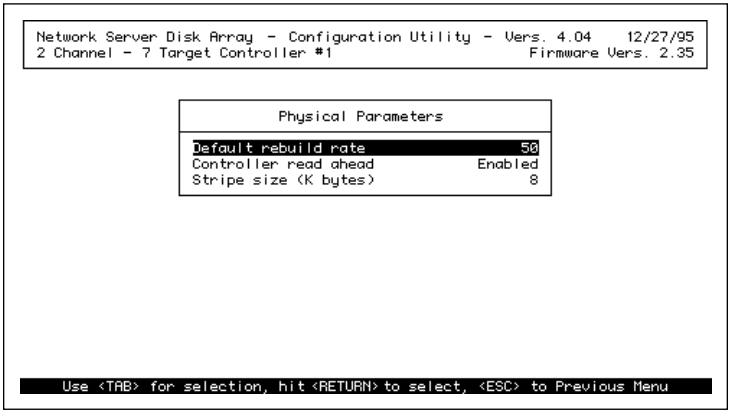
1 **Choose Advanced Functions from the Main Menu.**

The Edit/View Parameters menu appears:



2 **Choose Physical Parameters from the Advanced Functions menu.**

The Physical Parameters menu appears:



3 **Tab to highlight the "Stripe Size (K bytes)" menu item.**

4 **Press and release the Return key until the desired stripe size value appears.**

5 **Press Escape twice to return to the Main Menu.**

Disk abbreviations at a glance

You are now ready to proceed with configuration. Each step in the process is illustrated by a screen that shows the current state of the array. The screens use three-letter abbreviations for disk state. These abbreviations are explained in the following chart:

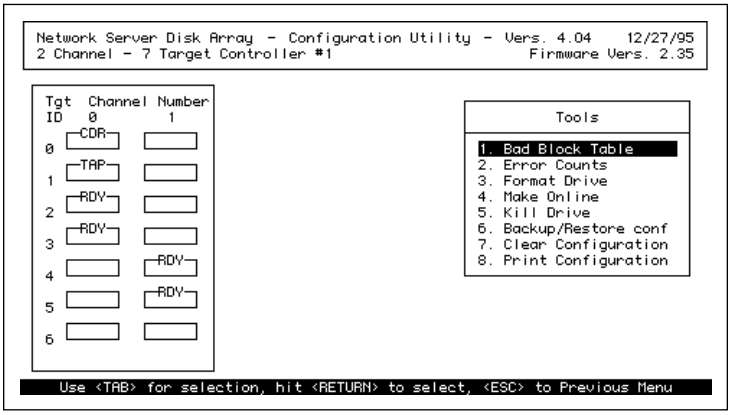
Abbreviation	Disk State
RDY	The disk is ready for operation, but not yet included in a pack.
DED	The disk is dead, or has been taken offline.
SBY	The disk is a standby (hot spare) drive.
ONL	The disk is operational and has been included in a pack. (It's online.)
FMT	The disk is being formatted.
WOL	The disk is being rebuilt from data and/or parity on other disks in the system drive. (WOL means write only. A disk cannot be read from while it's being rebuilt.)
UNF	The disk is unformatted. (It needs to be formatted.)
TAP	The device is a tape drive.
CDR	The device is a CD-ROM drive.

Low-level formatting

Low-level formatting completely erases a disk, performs a media surface check, and completely reformats the disk. The procedure is time-consuming and rarely necessary for new disk drives, which are almost always preformatted at the factory. The procedure can often restore damaged disks. If a damaged disk cannot be reformatted, do not attempt to use the disk.

1 **Select Tools from the Main Menu.**

The Tools menu screen appears. A matrix of physical devices in the array is displayed on the left, with the Tools menu at the right.



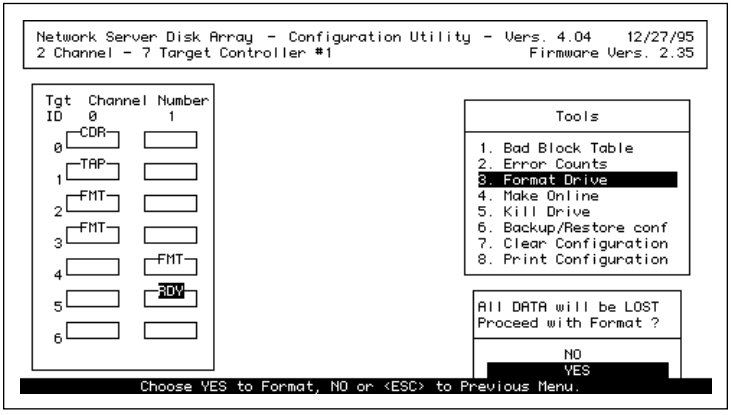
2 **Press and release the Tab key until Format Drive is highlighted.**

The highlight bar moves to the left side of the screen, positioned on the first device on the first channel of the array.

3 **If the disk you want to format is not highlighted, tab to it now.**

4 **Press Return.**

A dialog box appears at the lower right of the screen:



5 **To format the drive, tab to highlight Yes in the dialog box and press Return.**

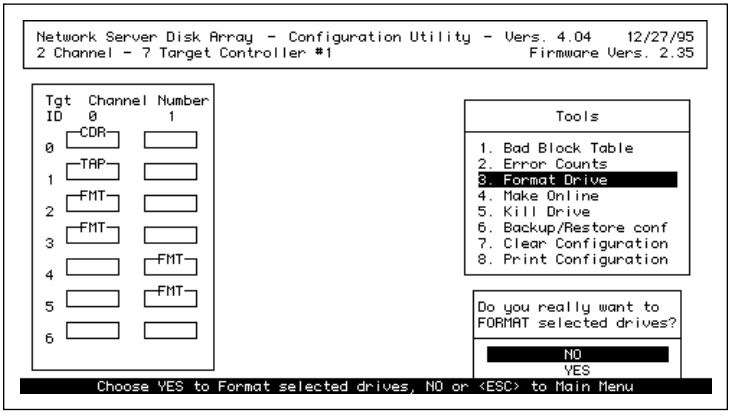
The dialog box disappears, and the disk state as represented in the matrix changes to FMT.

Note: If you decide to exclude a drive from formatting, you instead tab to highlight No and press Return. The dialog box disappears, and the disk state stays RDY.

6 **Repeat steps 3–5 to designate additional disks for formatting.**

7 **After all disks have been selected, press Escape.**

A dialog box appears at the lower right of the screen:



8 **To format the disks, tab to highlight Yes and press Return.**

Low-level formatting begins.

IMPORTANT If a disk cannot be formatted, a message appears giving its channel and SCSI ID. The disk should be replaced.

Note: To skip the format process for now, highlight No and press Return. (Formatting has not yet begun, so it is safe to stop at this point.) The Tools menu appears.

Messages on the screen inform you that formatting is in progress and then that it has been completed. After formatting has been completed, press Escape to return to the Main Menu.

Configuring the array

You can group disks into packs and then into system drives either automatically or manually. Automatic configuration has certain limitations but it is the fastest way to prepare an array for operation. Manual configuration gives you complete control of the array's design, but it takes longer and is more difficult. Before proceeding, read through the next two sections, covering both options, to determine which method is better for your installation.

Using automatic configuration

Automatic configuration is restricted to arrays of between three and eight drives, all of which must be of the same capacity.

Note: Different makes and models of disks with the same nominal size (1 gigabyte, 4 gigabytes, etc.) almost always have slight variations in capacity. Therefore it is best to use identical disks, of the same make and model, for automatic configuration.

The automatically configured array has the following properties:

- All disks are contained in a single pack.
- The pack is defined as a single RAID level 5 system drive.
- There are no standby (hot spare) disks defined.
- The write policy (write back or write through) must be selected during the configuration process.

To configure automatically, follow these instructions:

1 **In the Main Menu, tab to highlight Automatic Configuration.**

If the array is not appropriate for automatic configuration, because it has more than eight or fewer than three disks, or disks of varying size, the Configuration Utility presents a message telling you that automatic configuration cannot be done. If this happens, proceed to "Using Manual Configuration," later in this chapter.

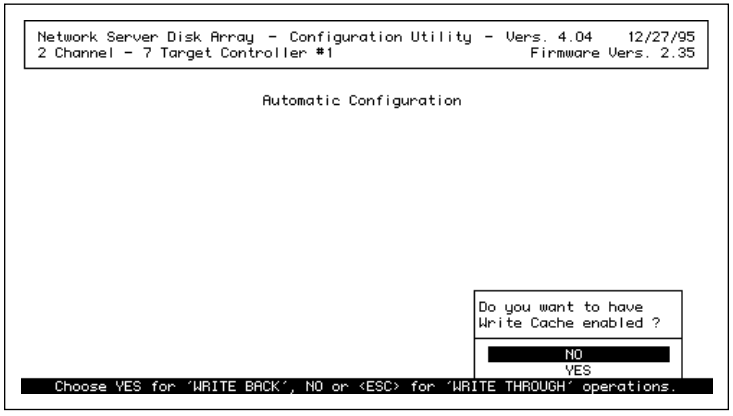
If a valid configuration already exists, the Configuration Utility presents a warning to that effect and asks for a confirmation to proceed.

> **WARNING** Overwriting an existing configuration will result in the complete and irreversible loss of any data stored on disks in the array.

2 **To proceed with the configuration, tab to highlight Yes and press Return.**

Note: To stop configuration, tab to highlight No and press Return. The Main Menu appears.

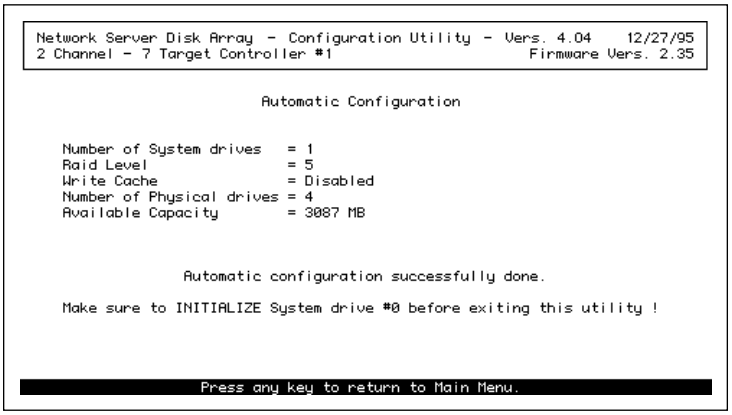
3 **Select a write policy for the system drive, as shown next:**



- To enable Write Cache, thereby setting the write policy to write back, tab to highlight Yes and press Return.
- To disable Write Cache, thereby setting the write policy to write through, tab to highlight No and press Return.

Note: With a write-back policy (which uses cache memory on the controller to store data temporarily), data is written to disk more quickly than with a write-through policy, which does not use cache memory. However, in the event of a power failure, any data in the cache will be lost unless the card has a battery backup or the server is equipped with an uninterruptible power supply (UPS). Because every Network Server PCI RAID Disk Array Card is equipped with a battery backup, the danger is minimized. However, there is still risk of data loss if the power failure is longer than the two to five hours estimated battery life.

Once the appropriate option has been selected, the configuration is saved and a summary screen similar to the one shown below appears:



3 **Press any key to return to the Main Menu.**

4 **Initialize the system drive.**

Follow the instructions in “Initializing the System Drives,” later in this chapter.

Using manual configuration

Manual configuration is more complex but more flexible than automatic configuration.

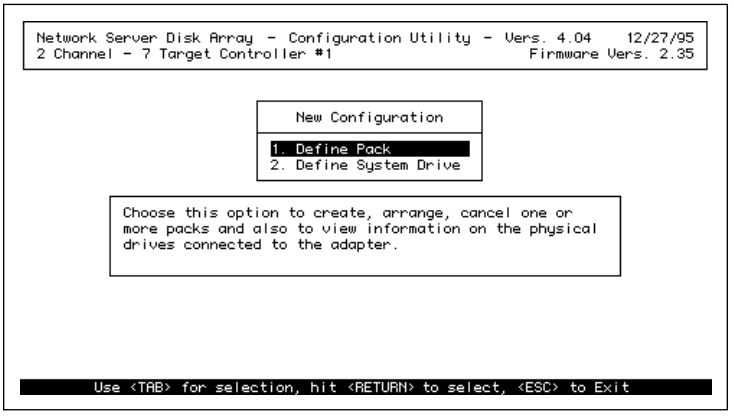
> **WARNING** Overwriting an existing configuration will result in the complete and irreversible loss of any data stored on disks in the array.

Defining packs

Defining packs is the first step in creating the new configuration.

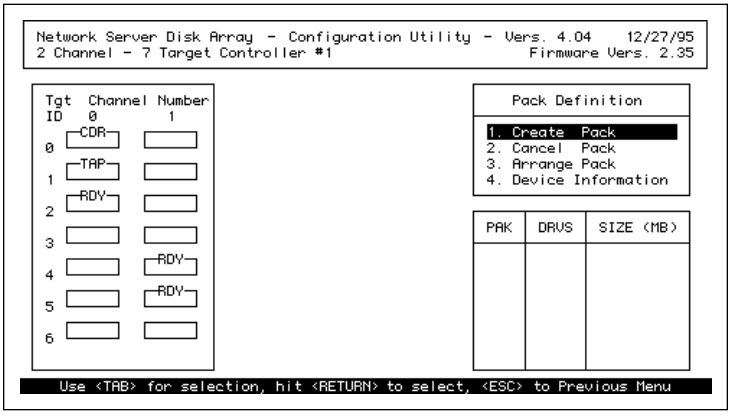
1 **In the Main Menu, tab to highlight New Configuration and press Return.**

The New Configuration menu appears:



2 **Press Return.**

The Pack Definition screen appears:



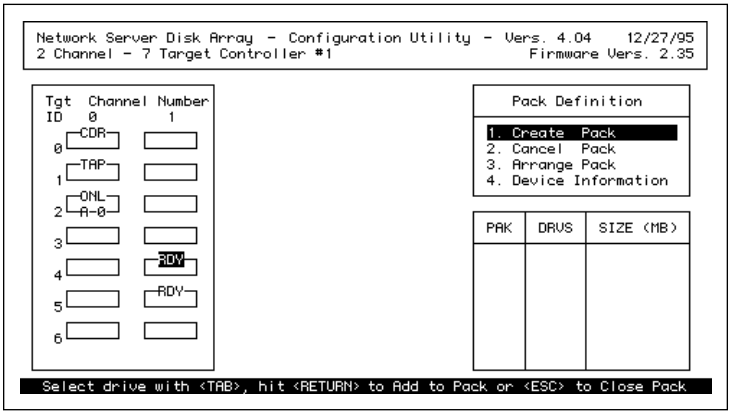
3 Press Return.

The highlight bar moves to the first device in the list at the left.

4 Tab to highlight the first RDY disk that you want in the pack.

5 Press Return to include the disk in the pack.

The disk is assigned a pack identifier (A, B, C,…) and disk identifier (0, 1, 2,…) within the pack and the disk status changes to ONL:



6 **Repeat steps 4 and 5 for all disks you want to include in the pack.**

Packs can include disks on different channels, up to the limit of eight disks. A pack can include disks of varying capacities, but it is good practice to avoid this. The total capacity of the pack equals the product of the number of disks times the capacity of the smallest disk.

7 **When the pack is complete, press Escape.**

The Pack Definition menu appears.

8 **Repeat steps 3–7 to create additional packs.**

If you create two to four packs, one right after the other, with the same number of disks in each one, these packs will be grouped together when you arrange them, as described in "Arranging Packs," later in this chapter. For more information on the advantages and disadvantages of combining packs, see "Combining Packs," also later in this chapter.

Changing or deleting a pack

To change a pack, you must first delete the pack and then recreate it. To delete a pack, follow these instructions:

1 **In the Pack Definition menu, tab to highlight Cancel Pack and press Return.**

The last pack created is deleted.

2 **To delete the next most recently created pack, press Return again.**

Note: The cancellation process works in a backwards sequence, starting with the most recently created pack. Once the most recently created pack has been cancelled, you can, if necessary, cancel the next most recently created pack, and so on. You cannot skip packs. Therefore, if you have, for example, created three packs, and want to cancel the first one you created, you'll need to cancel the third and then the second to get to your target. Be sure to make a note of which disks were included in which packs. Using that record, you can quickly recreate the packs you need.

Creating a standby or hot spare disk

To create a standby, or hot spare disk, do not include the device as a part of any pack. The device status will change from RDY to SBY when the configuration is saved to the controller's memory. Saving the configuration is explained later in this chapter.

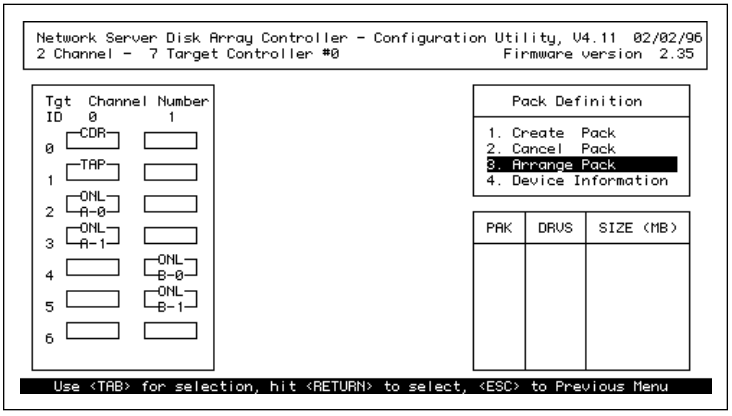
Arranging packs

After you have created packs, you need to arrange them so that they can be used for system drive creation.

Note: If you included all disks in a single pack, arrangement is automatic. If this is the case, skip to "Creating System Drives" later in this section.

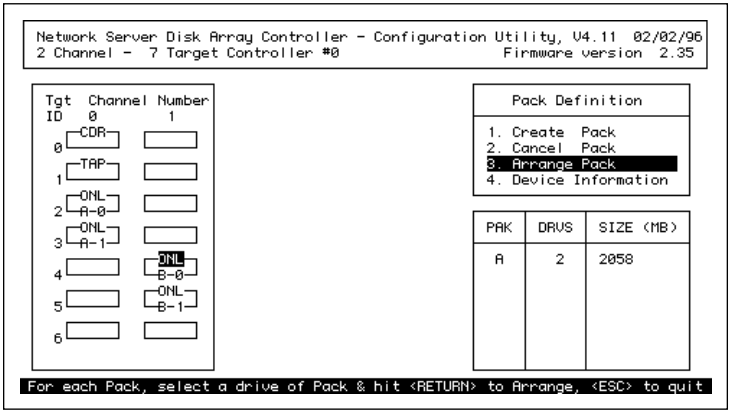
1 **In the Pack Definition menu, tab to highlight Arrange Pack and press Return.**

The pack arrangement screen appears:



2 **Tab to highlight any disk in the pack and press Return.**

The pack is added to the Pack Arrangement Table on the lower right side of the screen. The table displays the pack identifier for, the number of disks in, and the capacity of each arranged pack.



3 **Repeat steps 1 and 2 to arrange additional packs.**

After all packs are arranged, the New Configuration menu appears.

Combining packs

If you create and arrange two to four packs, one right after the other, with the same number of disks in each pack, the Configuration Utility groups those packs together. Such combined packs are sometimes called *superpacks*. The Configuration Utility automatically treats a combined pack as a single pack when creating system drives. There are two key advantages to this:

- If the individual packs support RAID levels 5 or 6, and one of those levels is assigned to the system drive, data is striped across the group of packs in addition to within each pack. This provides increased performance.
- System drives based on combined packs can contain more than the usual maximum of eight disks.

There are also two important disadvantages:

- The system drive is restricted to those RAID levels that would be supported by every pack on its own.
- The overhead for that RAID level will be subtracted from each pack.

For example, if you create a RAID 5 system drive from two 3-disk packs, the overhead will be one disk per pack, or two disks. If you create a RAID 5 system drive from one 6-disk pack, the overhead is again one disk per pack, or one disk.

In general, unless you need to include more than eight disks in a system drive, create and arrange packs such that each system drive includes no more than one pack.

If you do need to create two or more packs with the same number of disks, but you don't want to combine the packs, create them one of these two ways:

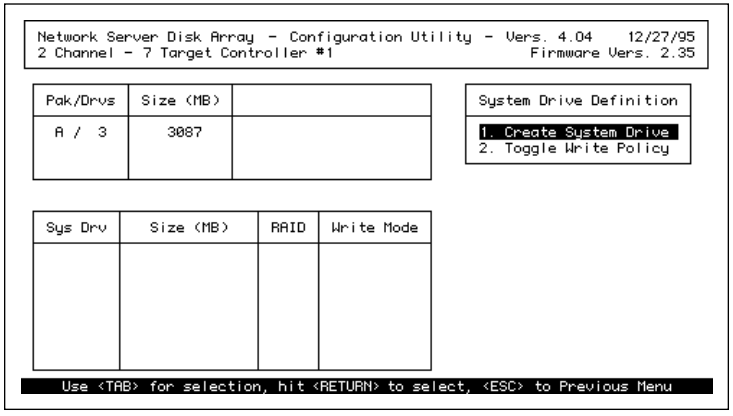
- Create a pack with a different number of disks in between each pair of packs that have the same number of disks.
- Create and arrange one pack, create a system drive from it, and initialize that system drive before creating the next pack.

Creating system drives

To create a system drive, follow these instructions:

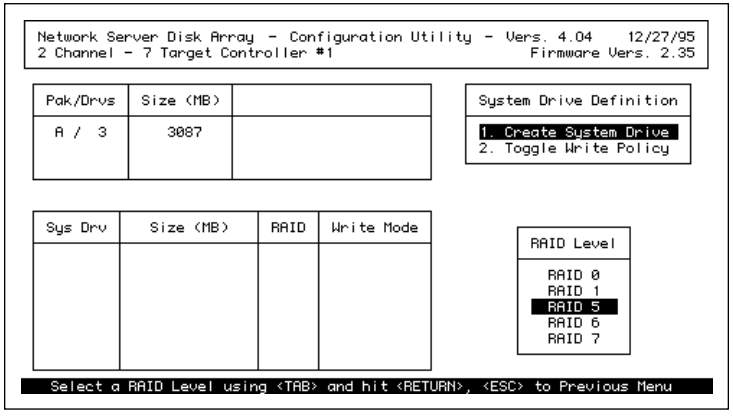
1 **In the New Configuration menu, tab to highlight Define System Drive and press Return.**

The System Drive Definition screen appears with Create System Drive highlighted. This screen displays all arranged packs, the System Drive Definition menu, and the System Drive Table, which should be empty, because there are no defined system drives as yet.



2 **Press Return.**

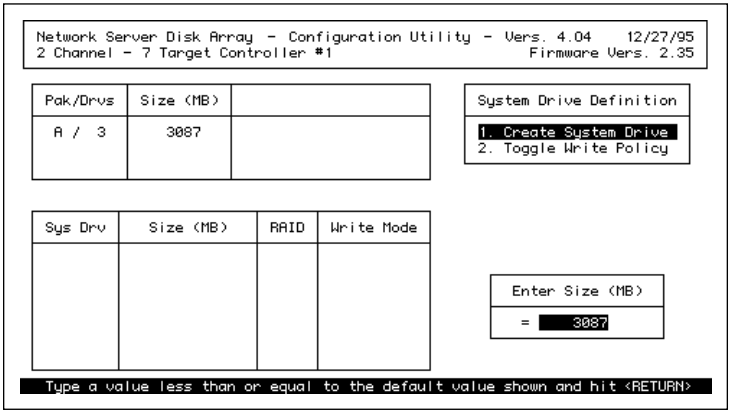
The RAID Level menu appears at the lower right of the screen:



3 **Tab to highlight the RAID level you want and press Return.**

Only RAID levels valid for this system drive can be highlighted.

4 **Define the size of this system drive in the Enter Size (MB) box at the lower right of the screen:**

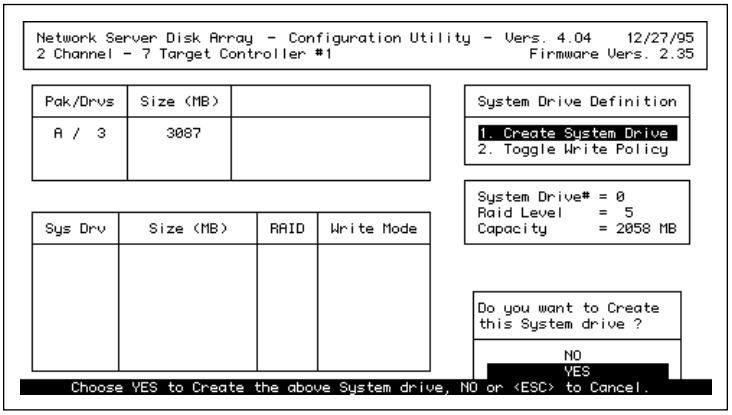


The maximum possible size for the system drive you're defining is displayed as the default.

- To accept the default capacity, press Return.
- To specify a smaller capacity, type the size in megabytes you want allocated to the system drive and press Return.

Specifying a smaller capacity allows you to create more than one system drive from a given pack.

A dialog box appears at the lower right of the screen, asking you to confirm the system drive settings:



5 To create the system drive, tab to highlight Yes and press Return.

The system drive is added to the system drive table, and the original System Drive Definition screen appears.

Note: If you decide to cancel the creation of the system drive, tab to highlight No and press Return. The system drive is not added to the system drive table, and the original System Drive Definition screen appears.

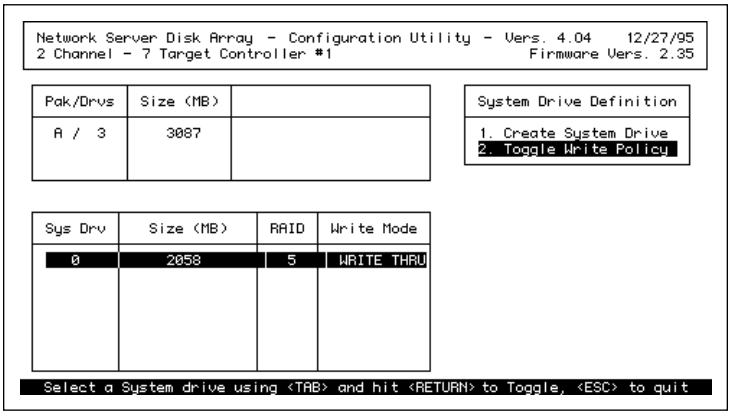
6 If you want to create additional system drives, start at the beginning of this section ("Using Manual Configuration"). Define and arrange the pack or packs you want in your next system drive, then create the new system drive starting with Step 1 here.

7 Set the write policy for each system drive.

If you don't set the write policy, all system drives will have a write through policy. Set the write policy from the System Drive Definition menu as follows:

1. Tab to highlight Toggle Write Policy.

   The write policy of the first system drive in the system drive table becomes highlighted:



2. Press Return to select the highlighted system drive or, if you have more than one system drive, tab to highlight the system drive for which you want to change write policy and press Return.

   The write policy changes from write through to write back or vice versa.

3. To change the write policy of additional system drives, repeat steps 1 and 2.
4. Press Escape to return to the original System Drive Definition screen.

Saving the New Configuration

Once all of the system drives are defined, the configuration must be saved to the controller's memory. To save the configuration, follow these steps:

1 **From the System Drive Definition screen, press the Escape key twice.**

Initializing the system drives

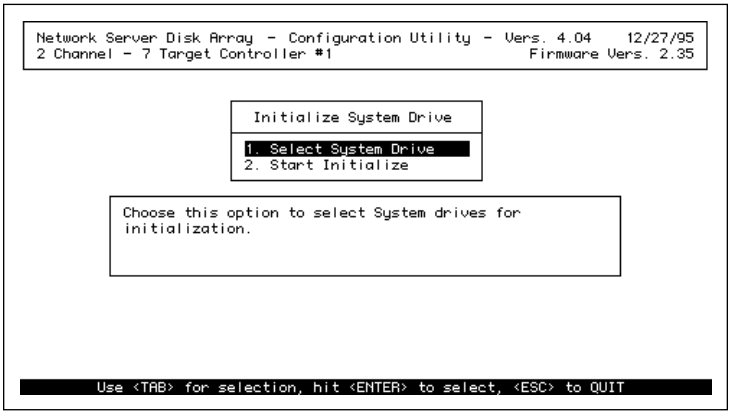
The last step in the preparation of the array is the initialization of the system drives. All system drives should be initialized immediately after they are created.

> **WARNING** Be sure to initialize system drives before using them. Any data placed on uninitialized system drives is at risk.

To initialize system drives, follow these instructions:

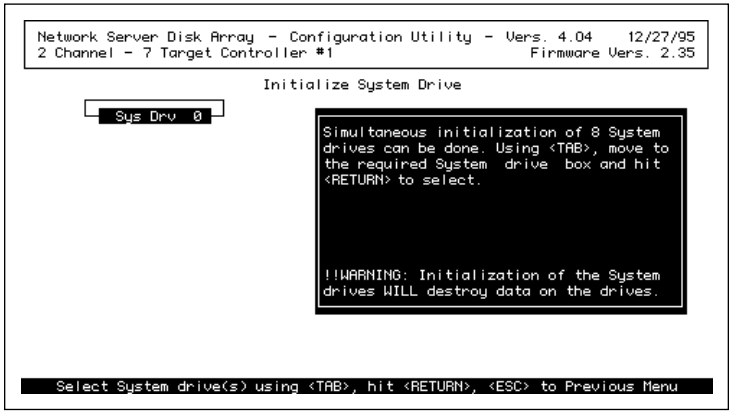
1 **In the Main Menu, tab to highlight Initialize System Drive.**

The Initialize System Drive menu appears:



2 **Make sure that Select System Drive is highlighted and press Return.**

The system drive selection screen appears:



3 **If you have more than one system drive, tab to highlight the system drive you want to initialize.**

4 **Press Return.**

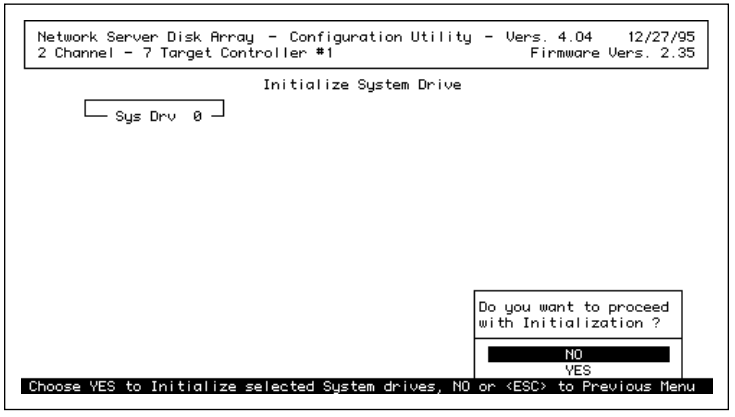
5 **Repeat steps 3 and 4 until all system drives have been selected for initialization.**

6 **Press Escape.**

The Initialize System Drive menu appears.

7 **Tab to highlight Start Initialize and press Return.**

A dialog box appears at the lower right of the screen:



8 **Tab to highlight Yes.**

An initialization status screen appears, showing the progress of each drive.

Note: The speed of initialization for a given system drive varies according to the system drive's size and RAID level.

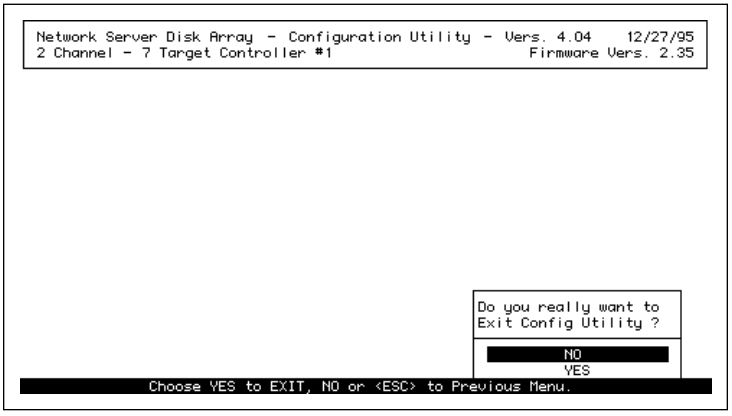
> **WARNING** Do not interrupt the initialization process.

9 **When you see an onscreen message announcing that initialization is complete, press any key to return to the Main Menu.**

If you need to configure additional controllers, return to "Selecting a Controller to Configure," earlier in this chapter. Complete the entire configuration procedure for each additional controller.

10 **When configuration of all controllers is complete, press Escape from the Main Menu to exit from the Configuration Utility.**

A confirmation dialog box appears at the lower right of the screen:



11 **Tab to highlight Yes to exit from the utility and press Return.**

Installing AIX

Once RAID has been fully configured, the physical disks are ready for use, and the operating system can be safely installed. The AIX software is provided on a CD-ROM disc included in your Network Server accessory kit. To begin the installation, use the following procedure:

1. **Insert the AIX installation disc in the CD-ROM drive of the Network Server.**
2. **Turn the key on the front of the Network Server to the left (service) position.**
3. **Reboot by pressing the Reset button on the front of the Network Server.**

   The Open Firmware prompt appears.

4. **Type one of the following instructions and press Return:**

   Determine which card controls the system drive on which you want to install AIX. Determine which slot that card is in. Then choose the appropriate instruction from the following list:

   Slot 1 `boot pci1/dac960@d/sd@0:aix`
   Slot 2 `boot pci1/dac960@e/sd@0:aix`
   Slot 3 `boot pci2/dac960@d/sd@0:aix`
   Slot 4 `boot pci2/dac960@e/sd@0:aix`
   Slot 5 `boot pci2/dac960@f/sd@0:aix`
   Slot 6 `boot pci2/dac960@10/sd@0:aix`

IMPORTANT If your CD-ROM drive is not in the top drive bay on the front of the Network Server, and thus does not have SCSI ID 0, you will need to change the 0 (zero) in whichever command you use to the SCSI ID number of the CD-ROM drive (determined by the bay in which the CD-ROM drive is installed).

For example, if the CD-ROM drive running the AIX installation disk has SCSI ID 2, the part of the command that relates to the CD-ROM drive would change to this:

```
sd@2
```

After a few moments, the first AIX installation screen appears. From this point on, installation proceeds exactly as it would without RAID. Follow the instructions in Chapter 2, “Installing AIX on Your Network Server,” of *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

4

Administering the Disk Array With the Configuration and Diagnostics Utilities

The Network Server PCI RAID Disk Array Configuration Utility provides a range of disk array monitoring and management features. These include the ability to alter and restore the configuration, to rebuild drives, and to change a variety of default parameters. The Network Server PCI RAID Disk Array Diagnostics Utility provides tests to isolate problems with the RAID card or with the disks under its control. The chapter describes both utilities; it also includes information on finding support when a malfunction is detected.

> **WARNING** These utilities are easy to use but very powerful. Follow all instructions exactly to avoid system failures.

Many of the administrative capabilities of the Configuration Utility are duplicated in the Network Server PCI RAID Disk Array Manager, as discussed in the next chapter, “Administering the Disk Array With the Disk Array Manager.” Because the Disk Array Manager provides graphical monitoring and does not require you to shut down AIX, it is in general the better choice.

Starting the Configuration Utility

The Network Server PCI RAID Disk Array Configuration Utility runs under Open Firmware, which can't be accessed while AIX is running. To start the Configuration Utility, follow these steps:

1. **Reboot the Network Server.**

   The safest method of rebooting is to type *shutdown -r* at the AIX prompt and then press Return. This procedure notifies connected users of the shutdown. There is then approximately a one-minute delay before rebooting begins. If no users are connected, type *reboot* and press Return.

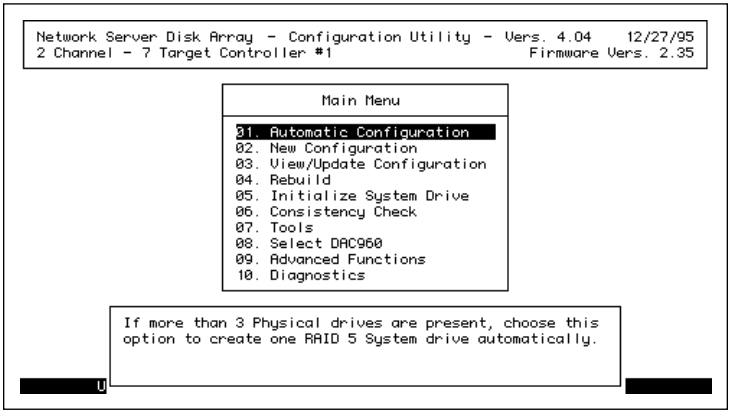
2. **As soon as the screen goes black and rebooting begins, press and hold *Option - Command-O -F* until the Open Firmware prompt appears.**

3. **Insert the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk.**

4. **At the Open Firmware prompt, type the following instruction exactly and press Return.**

   ```
   boot fd:dacconf.ns
   ```

   After a short interval, the Main Menu appears:



You can now use any of the utility's management features.

Viewing and updating the current configuration

The options in the View/Update Configuration menu allow you to view pack structure and arrangement, system drive structure, and system drive RAID levels and write policies. You can also use View/Update Configuration to add packs, system drives, and standby disks, or to change the write policy of any system drive. These additions and changes are made within the existing configuration and without overwriting the hard disks under RAID control.

Viewing the configuration

If you have one RAID card, start with step 3. If you have more than one card, follow all the steps for each card whose configuration you want to view.

1. **In the Main Menu, press and release the Tab key until Select Controller is highlighted and press Return.**

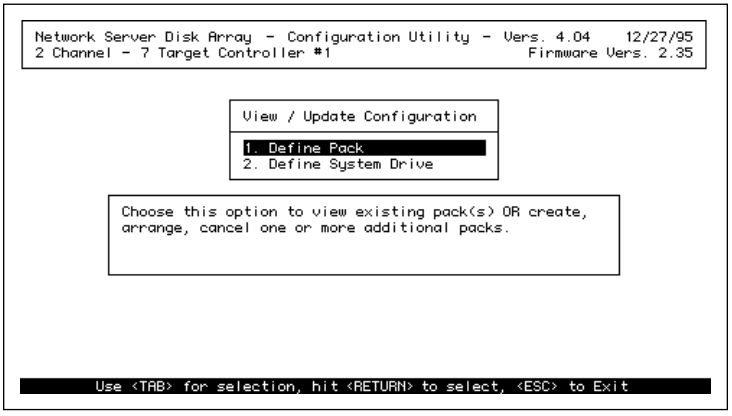
   The Select Controller menu appears.

2. **Tab to highlight the correct controller and press Return.**

   The Main Menu reappears.

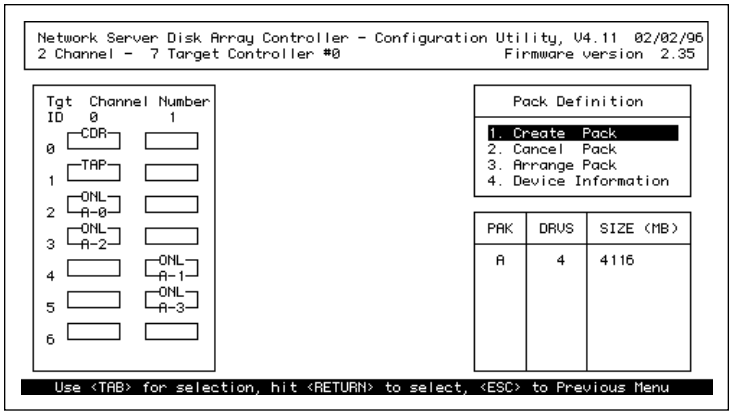
3. **In the Main Menu, tab to highlight View/Update Configuration and press Return.**

   The View/Update Configuration screen appears.



Viewing packs

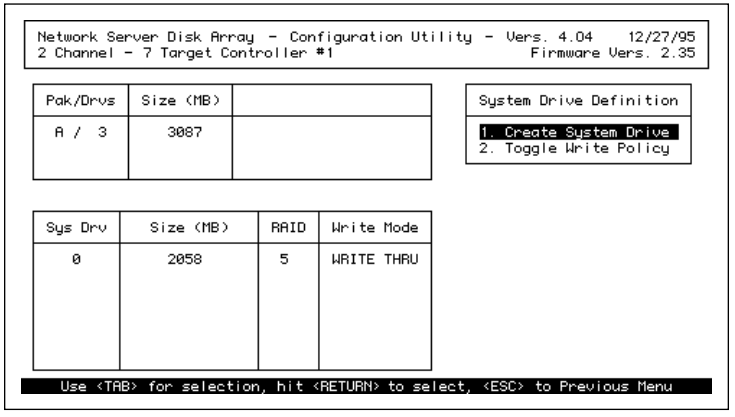
If you press Return, you see the Pack Definition screen, which is exactly the same screen you worked with when creating packs under the New Configuration menu:



The matrix at the left shows the disks with their pack and disk identifiers. The table at the lower right shows the size and number of disks in each pack.

Viewing system drives

If you tab to highlight Define System Drive and press Return, you see the System Drive Definition screen, which again is exactly the same screen you worked with when creating packs under the New Configuration menu:



The top table on the left shows you the number of disks in and the total size of each pack. The lower table shows you the the identifying number, size, RAID level, and write policy of each system drive.

Creating new packs and system drives

You create new packs and system drives exactly as you would when you set up a new configuration, except that you must initiate their creation from the View/Update Configuration screen rather than from the New Configuration screen. All other steps are exactly the same. For the complete procedure, see "Defining Packs," "Arranging Packs," and "Creating System Drives," in the section "Using Manual Configuration" in Chapter 3.

> **WARNING** Be sure to add packs and system drives by choosing View/Update Configuration, not New Configuration, from the Main Menu. Using New Configuration will overwrite the existing configuration, and all data on all disks in the array will be lost.

Adding standby disks

If you are adding new disks and want to put the disks on standby, follow these instructions:

1. **In the Main Menu, tab to highlight View/Update Configuration and press Return.**
2. **Tab to highlight Define Pack and press Return.**
3. **Verify that the new disk or disks have a status of RDY.**

   If the status of any disk is UNF, the device requires low-level formatting, described in Chapter 3.
4. **Press Escape.**

   The View/Update Configuration screen appears.

5 **Press Escape again.**

The Pack Definition screen appears, with a dialog box asking if you want to save the definition.

6 **Tab to highlight Yes and press Return.**

The status of the disk or disks changes from RDY to SBY.

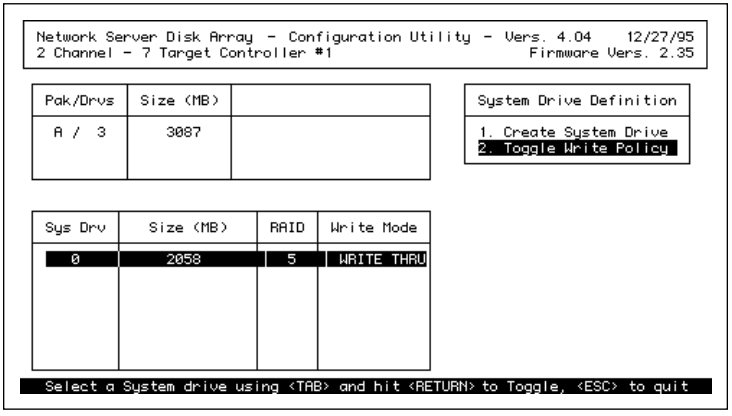
Changing write policy

To change write policy from write back to write through or vice versa follow these instructions:

1 **In the Main Menu, tab to highlight View/Update Configuration and press Return.**

2 **Tab to highlight Define System Drive and press Return.**

The System Drive Definition screen appears:



2 **Tab to highlight Toggle Write Policy.**

The write policy of the first system drive in the system drive table is highlighted.

3 **Tab to highlight the system drive for which you want to change the write policy.**

4 **Press Return.**

The write policy changes from write through to write back or vice versa.

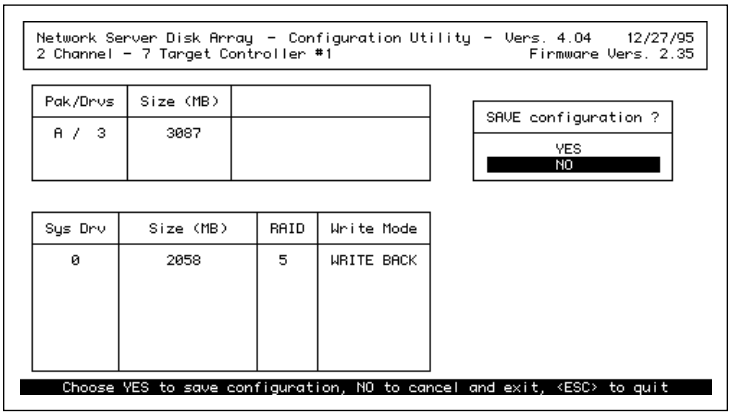
5 **Repeat steps 3 and 4 to change the write policy of additional system drives.**

6 **Press Escape.**

The original System Drive Definition screen appears.

7 **Press Escape twice more.**

The Save Configuration dialog box appears at the upper right of the screen:



8 **Tab to highlight Yes and press Return.**

The Main Menu appears.

Note: If you realize that you need to make additional changes, don't save the configuration. Press Escape instead. The System Drive Definition menu appears. All changes made so far are temporarily retained, and you can now make others. When you are finished working with system drives, you will return to the Save Configuration dialog box. You must save the configuration to complete array modifications.

Rebuilding on replacement disks

Rebuilding on a replacement disk means writing data and parity information from other disks in the array to the replacement disk. Rebuilding is restricted to disks in redundant (fault-tolerant) arrays, which are arrays at RAID levels 1, 5, or 6. If the array contains a hot spare (standby disk), rebuilding is automatic. If there is no hot spare, you can remove the damaged disk and replace it with another disk of the same SCSI ID and of equal or greater capacity.

If the fault-tolerant disk array supports hot-swapping and is AEMI-compliant, as the internal disk array in the Network Server is, rebuilding starts automatically when you install the replacement disk. If the disk array does not support hot swapping or is not AEMI compliant, you can manually initiate rebuilding after you install the replacement disk. If no hot spare or swappable disk is available, you can also attempt to rebuild the damaged disk itself, although this should be a last resort. Use the following instructions to replace the disk and to initiate rebuilding:

Replacing a disk

IMPORTANT If your disk array does not support hot swapping, shut down the Network Server before rebuilding. Steps 1 and 2 are not necessary, because the computer has been shut down. Follow the instructions from step 3. After step 4, reboot and start the Configuration Utility. For more information see "Starting the Configuration Utility" earlier in this chapter.

1. **Shut down the damaged disk.**

   To shut down a disk in an internal drive bay of the Network Server, pull back the drive tray eject lever on the drive bay. To shut down a disk in an external array, follow the directions in the user's guide that came with the external array.

2. **Wait 30 seconds.**

   This gives the disk time to spin down completely. It also gives the controller time to recognize that the damaged disk has been removed and to prepare to recognize the replacement disk.

3 **Remove the damaged disk.**

To remove a disk from an internal drive bay of the Network Server, pull the drive tray towards you until the tray comes free. To remove a disk from an external array, follow the directions in the user's guide that came with the external array.

4 **Install a disk of equal or greater capacity and the same SCSI ID as the damaged disk in the drive bay from which you removed the damaged disk.**

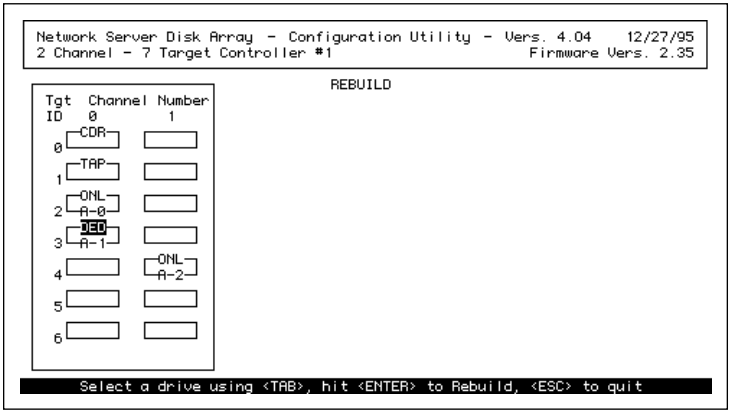
To install a disk in an internal drive bay of the Network Server, follow the directions in *Setting Up the Network Server.* To install a disk in an external array, follow the directions in the user's guide that came with the external array. If you are using an Apple-supplied disk in an internal drive bay of the Network Server, the SCSI ID is set automatically.

Rebuilding a disk

Manual rebuilding is necessary if your disk array does not support hot-swapping, or is not AEMI-compliant, or if you are attempting to rebuild a damaged disk, rather than a replacement disk. Follow these instructions to initiate rebuilding:

1 **In the Main Menu, tab to highlight Rebuild and press Return.**

The Rebuild screen appears:



2 **Tab to highlight the disk to be rebuilt.**

Even if the damaged disk has been replaced, the representation of the disk in the matrix has the status of DED.

A dialog box appears asking if you want to low-level format the disk. If you have swapped in a new disk, formatting is not necessary.

> **WARNING** If you are attempting to rebuild a damaged disk, low-level formatting is essential. See "Low-Level Formatting," in Chapter 3, for details.

3 **Press Return to initiate rebuilding.**

A Rebuild status screen appears, showing the progress of data reconstruction on all of the system drives dependent on the selected physical disk. After the process is complete, a message reports that rebuilding was successful.

Note: If read errors are encountered with any physical disks in the system drive, rebuilding fails. See "Monitoring the Condition of Disks," later in this chapter, for more information.

4 **Press any key to return to the Main Menu.**

Checking data and parity consistency

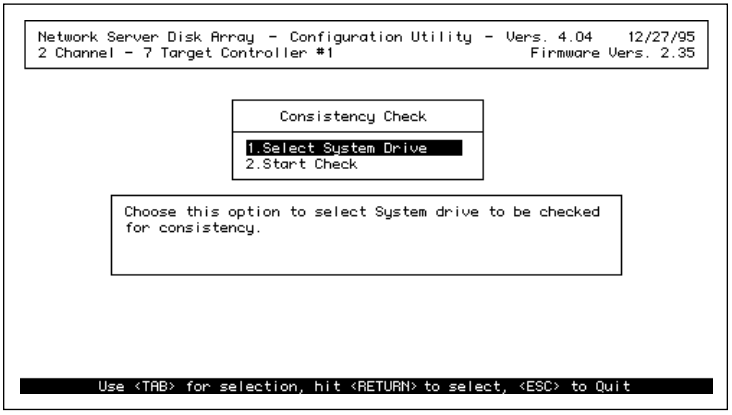
Running a consistency check compares the data and parity information on redundant system drives (those with RAID levels of 1, 5, or 6) to ensure that the system drives can continue to function in the event of a disk failure. If a difference between the data and its generated parity is detected (usually by viewing error counts, as discussed in "Viewing Error Counts," later in this chapter), the check can restore consistency automatically, or it can isolate the inconsistencies to help with further diagnosis and service. Only one system drive can be checked at a time.

WARNING Restoring consistency could mean data loss in the blocks that are inconsistent. Do not proceed with the consistency check until you have backed up all data from the system drive.

To check (and if necessary, restore) the integrity of a particular redundant system drive, follow these instructions:

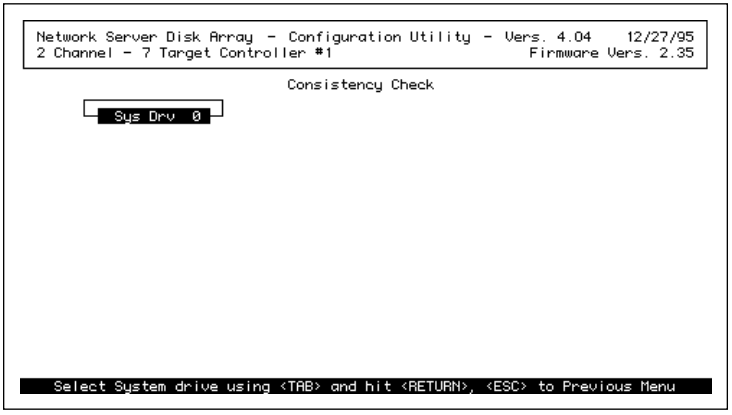
1 **In the Main Menu, tab to highlight Consistency Check and press Return.**

The Consistency Check menu appears:



2 **Make sure Select System Drive is highlighted and press Return.**

The system drive selection menu appears at the left:



3 **Tab to highlight the system drive you want to check and press Return.**

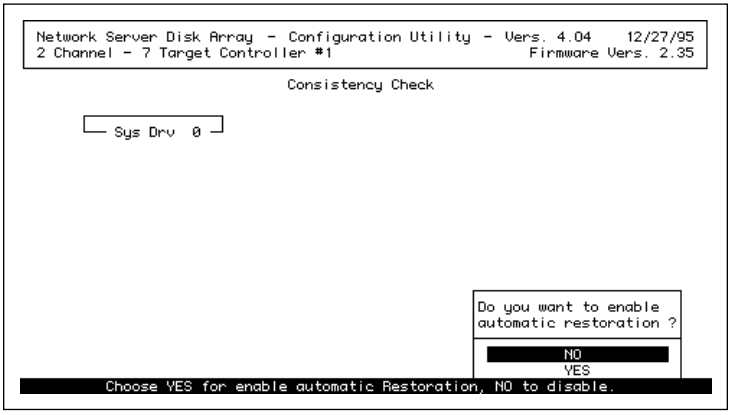
A checkmark appears by the system drive.

4 **Press Escape.**

The Consistency Check screen appears.

5 **Tab to highlight Start Check and press Return.**

A dialog box appears at the lower right of the screen:



6 **Tab to highlight Yes or No.**

Yes enables automatic restoration. When the check is complete, the controller attempts to restore consistency in the damaged sectors. However, doing so may cause some data loss, and that data will need to be replaced from the data backup.

No disables automatic restoration. When the check is complete, the RAID controller leaves the disk as is, but reports all inconsistencies.

7 **Press Return.**

Your choice is confirmed, and the consistency check begins.

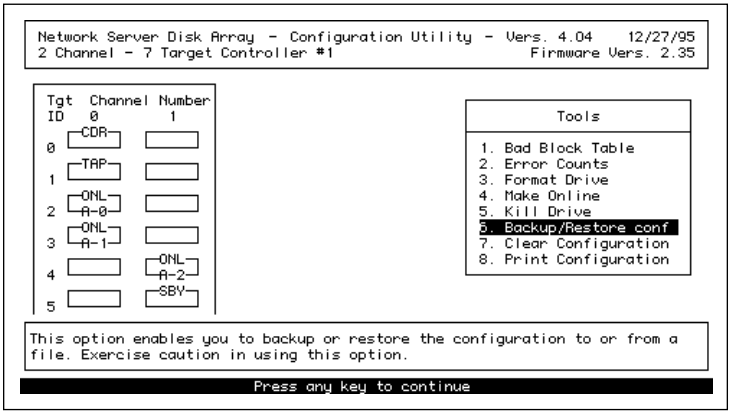
Backing up the configuration

Although configurations are stored in two memory locations on the controller, it is worthwhile to make a backup copy for safekeeping.

1 **In the Main Menu, tab to highlight Tools and press Return.**

2 **Tab to highlight Backup/Restore Conf.**

A caution message appears at the bottom of the screen:

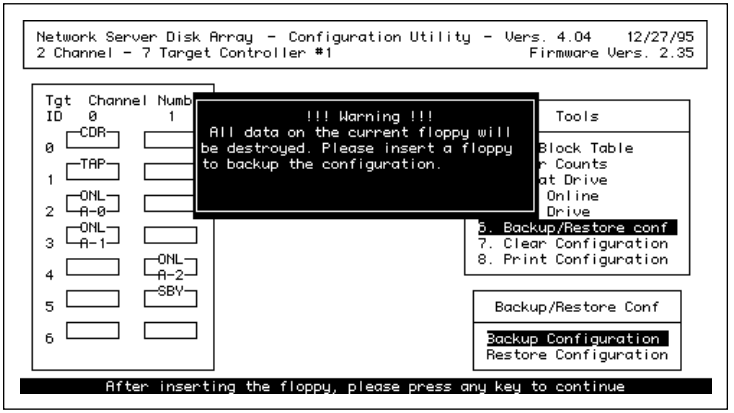


3 **Press any key to continue.**

The Backup/Restore Configuration dialog box appears at the lower right of the screen.

4 **Tab to highlight Backup Configuration and press Return.**

The *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk is ejected. A message appears prompting you to insert a new floppy disk.



5 **Insert a blank floppy disk in the floppy disk drive of the Network Server.**

6 **Press any key to continue.**

Messages at the bottom of the screen confirm the progress of the backup.

7 **Label the floppy disk to identify its contents and put it away for safekeeping.**

Restoring a configuration

You can restore a configuration using a backup disk:

1 **In the Main Menu, tab to highlight Tools and press Return.**

2 **Tab to highlight Backup/Restore Conf and press Return.**

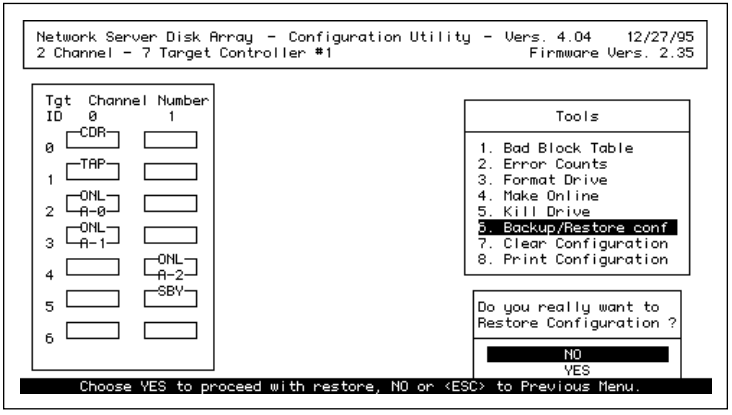
3 **Tab to highlight Restore Configuration and press Return.**

The *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk is ejected. A message appears that warns you that restoring the configuration will completely overwrite the existing configuration, and that asks you to insert the floppy disk containing the configuration you want to restore.

4 **Insert the backup floppy disk in the floppy disk drive of the Network Server.**

5 **Press any key to continue.**

A confirmation dialog box appears:



6 **To initiate the restoration, tab to highlight Yes and press Return.**

Messages on the bottom of the screen confirm the progress of the restoration.

Clearing a configuration

The Clear Configuration option erases an existing configuration from memory. All packs, system drives, and RAID levels are cleared. Controller parameters remain unchanged.

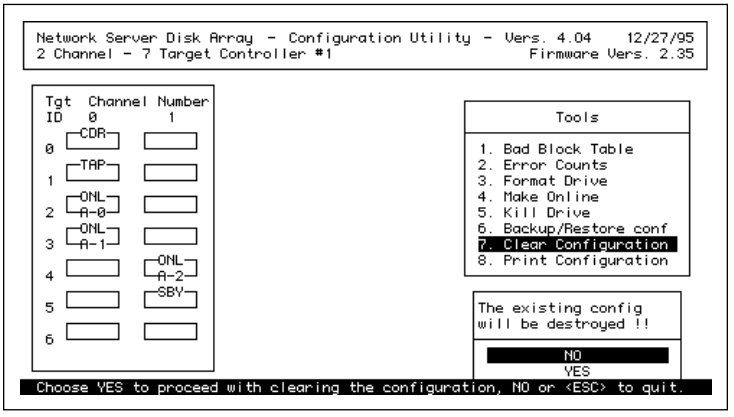
> **WARNING** The operating system, all applications, and all user data are lost when the configuration is cleared. Do not proceed until you have made a complete backup.

To clear a configuration, follow these instructions:

1 **In the Main Menu, tab to highlight Tools and press Return.**

2 **Tab to highlight Clear Configuration.**

The Clear Configuration confirmation dialog box appears at the lower right of the screen:



2 **Tab to highlight Yes and press Return.**

The configuration has been cleared. You can create a new configuration, following the instructions in Chapter 3, or you can use a restored configuration, following the instructions given earlier in this chapter.

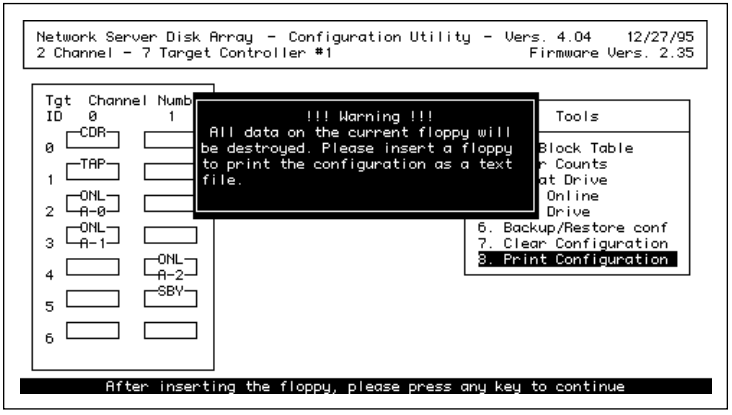
Printing a configuration

You can save a configuration as a text file and print it out. You can use the printout if you need to manually restore the configuration.

1 **In the Main Menu, tab to highlight Tools and press Return.**

2 **Tab to highlight Print Configuration and press Return.**

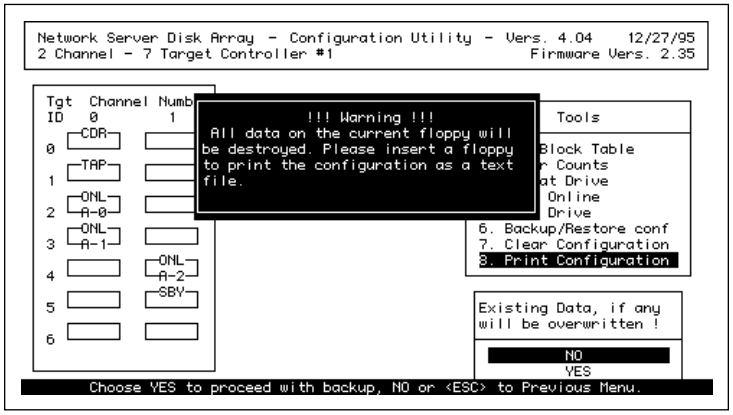
A message appears to warn you that the current floppy disk will be erased and to prompt you to insert a new disk. The Utilities disk is ejected.



3 **Insert a blank floppy disk in the floppy disk drive of the Network Server.**

4 **Press any key to continue.**

A dialog box appears asking you to confirm that you want to create the text file and warning you that any data previously on the disk will be erased:



5 **Tab to highlight Yes and press Return.**

The text file is created. After you exit from the Configuration Utility and reboot AIX, you can print the configuration from the floppy disk. The exact command to use appears on screen in the Configuration Utility. Write it down for future reference. It will be similar to the following, but will vary according to the size of the configuration file:

```
dd if=/dev/fd0 of=/tmp/dacconfig skip=256 count=20
```

If you need information about printing from AIX, see the AIX documentation available online through the InfoExplorer application. For more information on InfoExplorer, see Chapter 5, “Using InfoExplorer to Retrieve Information,” in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

Setting hardware parameters

The following hardware parameters for the Network Server PCI RAID Disk Array controller can be enabled or disabled:

- Battery backup

  Battery backup guards against data loss from the controller's cache memory. Battery backup comes with the Network Server PCI RAID Disk Array Card, and the parameter should be enabled.

- Array Enclosure Management Interface (AEMI)

  AEMI controls the LED displays on internal disks and provides automatic rebuilding of hot swapped disks. It should be enabled for a card connected to the internal drives of the Network Server, as well as for all AEMI-compliant external disk arrays. It should be disabled only for non-AEMI-compliant external disk arrays. Be sure to check the documentation for your external array before proceeding.

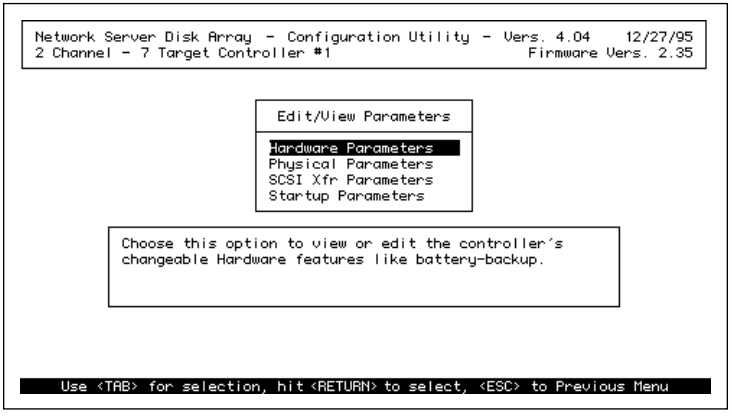
- StorageWorks Fault Management™

  This utility is not supported for the Network Server; the parameter should be disabled.

To change any of the hardware parameters, follow these instructions:

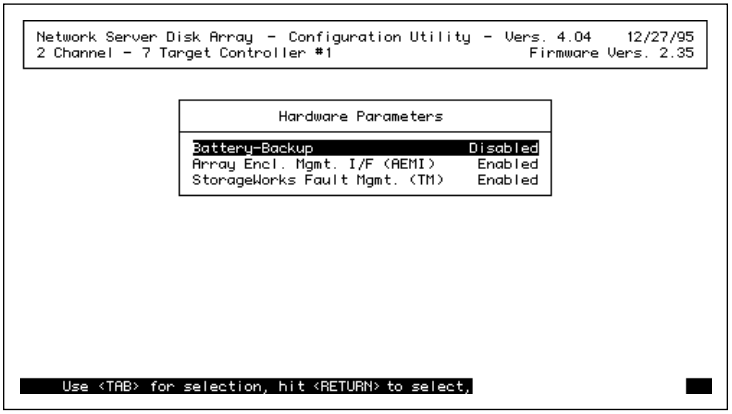
1 **In the Main Menu, tab to highlight Advanced Functions and press Return.**

The Edit/View Parameters menu appears:



2 **Make sure Hardware Parameters is highlighted and press Return.**

The Hardware Parameters menu appears:



3 **Tab to highlight the parameter you want to change and press Return to change its state.**

Pressing Return switches you back and forth between Enabled and Disabled.

4 **Repeat step 3 for each additional parameter you want to change.**

5 **Press Escape.**

All changes take effect immediately.

Setting physical parameters

The physical parameters of the Network Server PCI RAID Disk Array Controller define the interaction between the controller and the disk array in the following ways:

- The rebuild rate determines how quickly the controller rebuilds a disk. You specify a number between zero and 50. A higher number results in faster rebuilding but lower array performance.
- Stripe size adjusts controller performance to a specific environment or application. Because changing the stripe size always results in data loss, it is best to set this parameter before installing the operating system. See “Setting Stripe Size” in Chapter 3 for more information. If you need to adjust stripe size after the array is in operation, do a full backup first.

- Controller read ahead speeds up data retrieval by allowing the controller to read a full stripe of data at a time into the DRAM cache. It should always be enabled.

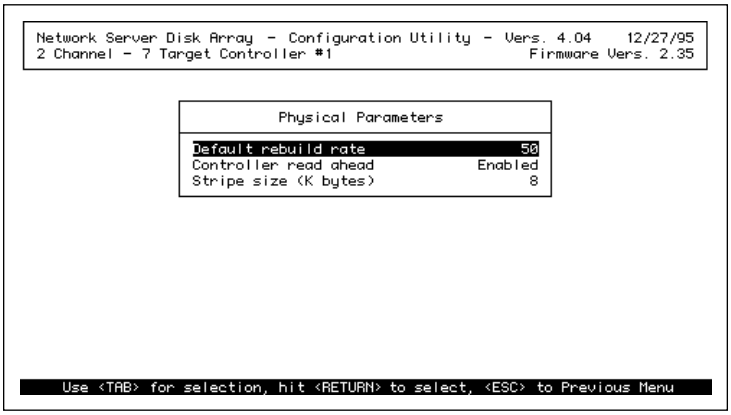
To change a physical parameter, follow these instructions:

1 **In the Main Menu, tab to highlight Advanced Functions and press Return.**

The Edit/View Parameters menu appears.

2 **Tab to highlight Physical Parameters and press Return.**

The Physical Parameters menu appears:



3 **Tab to highlight the parameter you want to change and press Return until the state or value you want is displayed.**

4 **Repeat step 3 to change each additional parameter.**

5 **Press Escape.**

All changes take effect immediately.

Setting device startup parameters

Device startup parameters for a Network Server PCI RAID Disk Array controller regulate the power consumption of the physical disks within the controller’s array:

The spinup mode controls how the SCSI disks are started (spun up). There are three spinup modes:

-

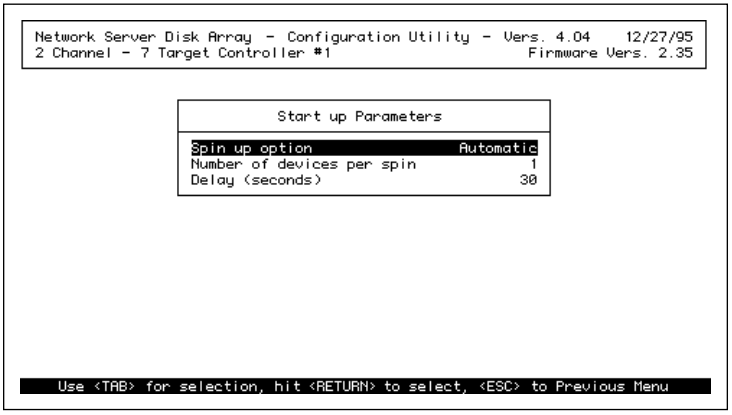
To change a parameter, follow these instructions:

1 **In the Main Menu, tab to highlight Advanced Functions and press Return.**

The Edit/View Parameters menu appears.

2 **Tab to highlight Startup Parameters and press Return.**

The Startup Parameters menu appears:



3 **Tab to highlight the parameter you want to change and press Return until the state or value you want is displayed.**

4 **Repeat step 3 to change each additional parameter.**

5 **Press Escape.**

All changes take effect immediately.

Monitoring the condition of disks

If disk problems develop, you can often isolate the source using the bad block and error count tables that the controller maintains.

- The View Rebuild Bad Block Table identifies problems that turn up during rebuilding. When a damaged disk in a fault-tolerant array (RAID level 0, 5, or 6) is replaced by a hot spare or a hot swapped disk, the controller reads data and parity information from the other disks in the pack, puts the data back in order and then writes the data to the replacement disk. If the controller detects a read error on any redundant disk, rebuilding fails. The View Rebuild Bad Block Table identifies the disk that is the source of the read error.
- The View Write Back Bad Block Table, which is maintained only for system drives set to write back, records all errors that occur during a read or write operation. Again it identifies faulty disks.

IMPORTANT Bad block tables are cleared when you close them. Be sure to record all information that you may need.

- Error count tables identify disks that need to be repaired or replaced. The following tables are maintained:

  SCSI bus parity errors, which are errors in information transfer. Frequent parity errors can result in data corruption.

  Soft errors, which are typically due to a bad disk sector. These errors are automatically corrected in a redundant array. Soft errors usually do not interfere with normal operation, but they are a predictor of future problems.

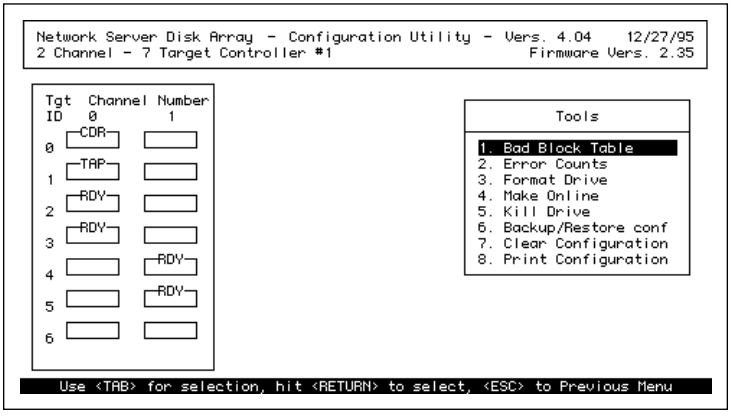
  Hard errors, which are generated by invalid commands to the hardware. During normal operation, the hard error count for any device should be zero. A hard error indicates that a disk is likely to fail.

  Miscellaneous errors, which most commonly are instances of devices timing out on commands (the default timeout limit is six seconds), or devices being busy when commands are sent. Occasional timing errors are usually inconsequential; frequent errors may mean that one or more parameters are incorrectly set for a given set of physical disks.

Viewing bad block tables

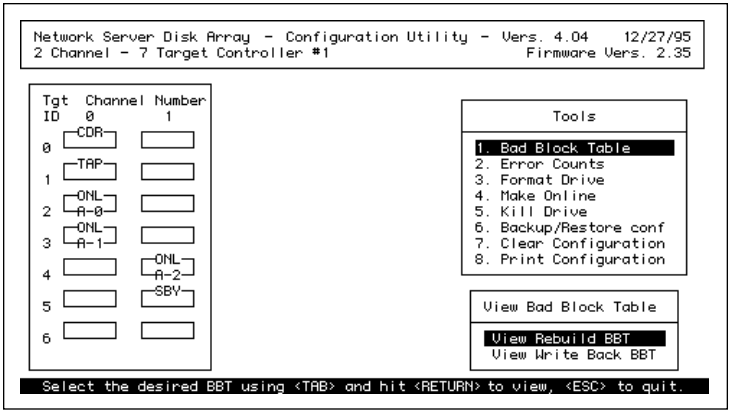
1 **In the Main Menu, tab to highlight Tools and press Return.**

The Tools menu appears with Bad Block Table highlighted:



2 **Press Return.**

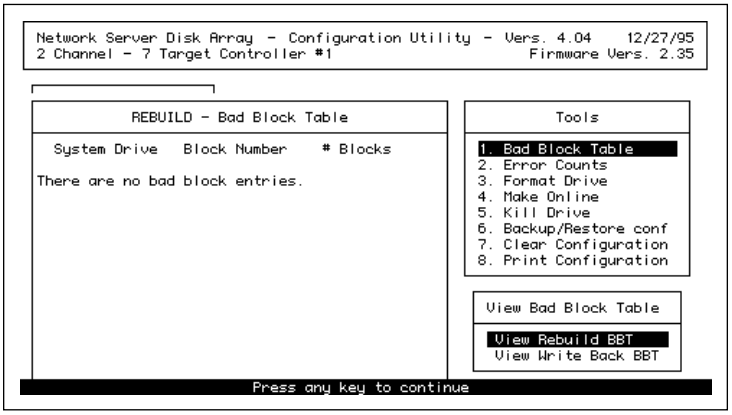
The bad block table dialog box appears at the lower right of the screen:



3 **Tab to highlight View Rebuild BBT or View Write Back BBT, and press Return.**

The View Write Back BBT option doesn't appear if the system drive is set to write through.

The bad block table you selected appears at the left:



4 **To view the other bad block table, if both are available, tab to highlight it and press Return.**

Viewing error counts

1 **In the Main Menu, tab to highlight Tools and press Return.**

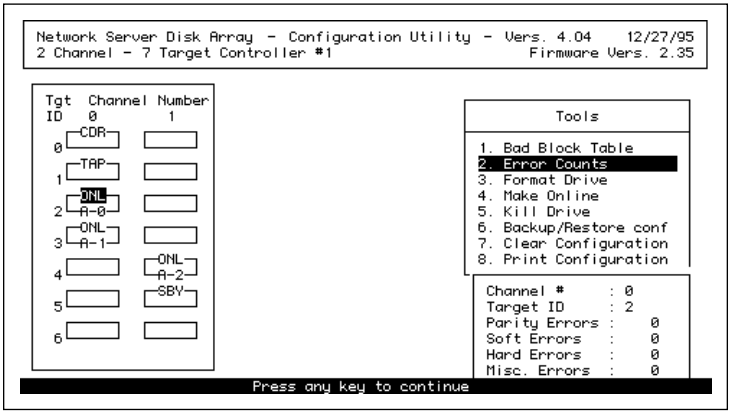
The Tools menu appears.

2 **Tab to highlight Error Counts and press Return.**

The first device on the first channel in the matrix at the left becomes highlighted.

3 **Tab to highlight the device you want to analyze.**

The error count table for that device is displayed at the lower right:



Using the Diagnostics Utility

Problems that do not respond to the solutions offered by the Configuration Utility or the Disk Array Manager may stem from malfunctions in the controller itself or in one or more disks. The Diagnostics Utility provides a series of tests that can help you isolate the source of the problem.

Opening the Diagnostics Utility

You open the Diagnostics Utility in the same way you open the Configuration Utility, except that you enter a different command at the Open Firmware prompt.

1 **Reboot the Network Server.**

The safest method of rebooting is to type `shutdown -r` at the AIX prompt and then press Return. This procedure notifies connected users of the shutdown.There will be approximately a one minute delay before rebooting begins. If no users are connected, type `reboot` and press Return.

2 **As soon as the screen goes black and rebooting begins, press and hold *Option-Command-O-F* until the Open Firmware prompt appears.**

3 **Insert the *Network Server PCI RAID Disk Array Configuration and Diagnostics Utilities* floppy disk.**

4 **At the Open Firmware prompt, type the following instruction exactly and press Return.**

```
boot fd:dacdiag.ns
```

After a short interval, the Diagnostics Utility opens.

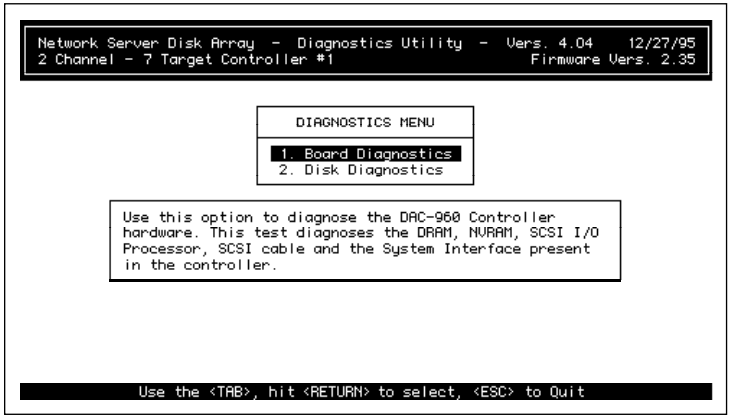
Selecting a controller

If you have one controller, the Diagnostics Menu, shown following step 2 of this section, appears as soon as the Diagnostics Utility opens. If you have more than one controller, a controller selection screen appears first. To select a controller, follow these instructions:

1 **Tab to highlight the controller you want to diagnose.**

2 **Press Return.**

After a short interval the Diagnostics Menu appears:



Running the board diagnostic tests

The board diagnostic tests probe all aspects of controller functionality:

- The Memory Test locates problems in NVRAM and DRAM.
- The Transfer Logic Test assesses data transfer by the system interface controller.
- The SCSI Interface Test checks information transfer on both SCSI channels.
- The SCSI I/O Processing Test measures I/O performance.
- The Loop Back Test assesses data transfer within the controller.

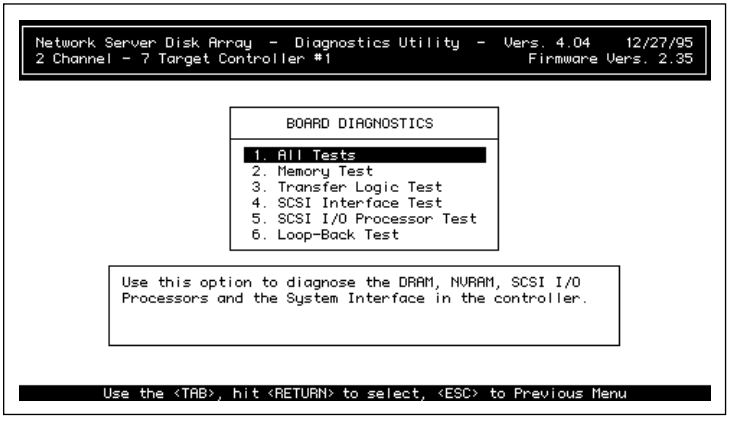
You can choose to run all or any one of these tests. Individual tests are further divided into subtests, of which you can run one or all. Unless you are fairly certain of where the problem lies, it is probably most efficient to choose the All Tests option.

Running all tests

Do the following procedure to run all board diagnostic tests:

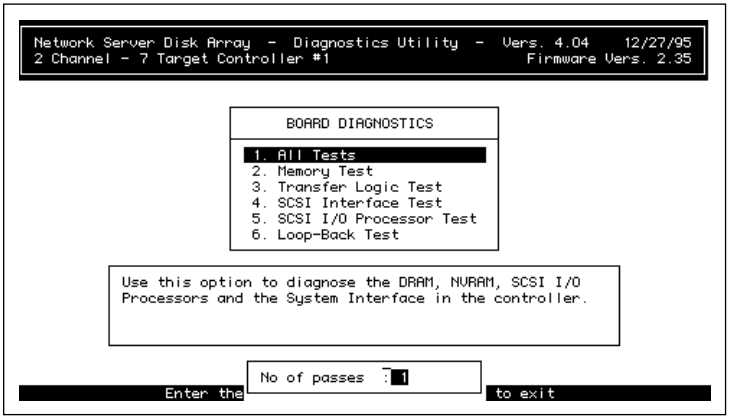
1 **In the Diagnostics Menu, tab to highlight Board Diagnostics and press Return.**

The Board Diagnostics menu appears:



2 **Press Return.**

The following screen appears:

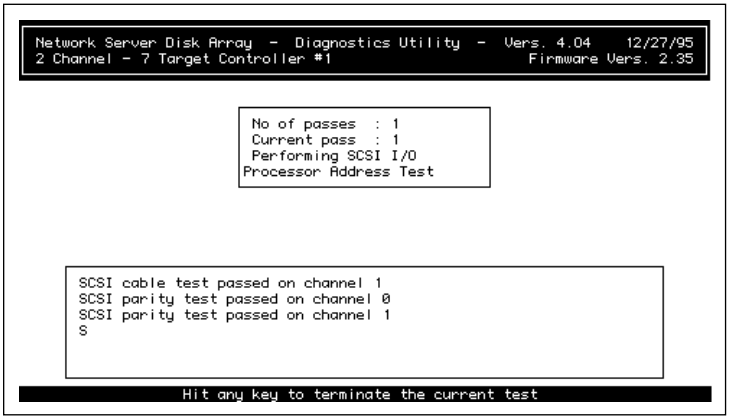


3 **Enter the number of times you want the utility to perform the test.**

Running the test more than once can find errors that occur infrequently.

4 **Press Return.**

The following screen appears, showing the tests in progress and each test's results as they become available:



IMPORTANT Watch the test results closely. The window is not scrollable, so the data disappears after it gets to the bottom of the results box, but the pace is slow enough to allow you to note any test failures.

5 **When all tests are complete, press any key to return to the Diagnostics Menu.**

If the board has passed all tests, you can exit from the utility or proceed to the disk diagnostics. If the board has failed one or more tests, make a note of the specifics. To get help, see "Obtaining Service and Support," later in this chapter.

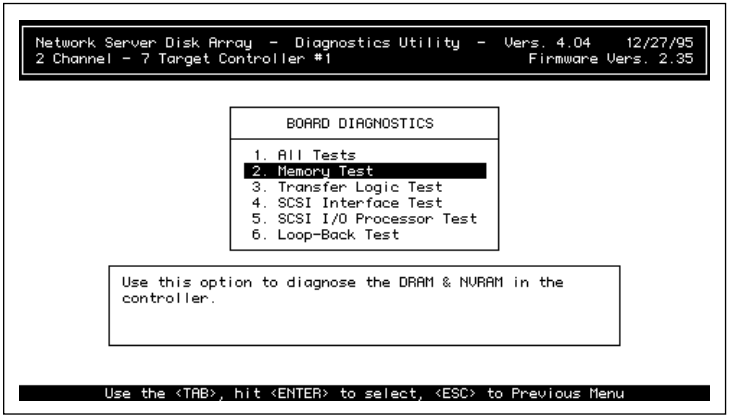
Running a specific test

You can run a specific test or subtest, but you can only run one test at a time. If you want to run a series of tests, but not all of the available tests, you need to select each test, complete it, and then go on to the next one. The procedure for each test is the same, and is very similar to the procedure given above for running all tests.

1 **In the Diagnostics Menu, tab to highlight Board Diagnostics and press Return.**

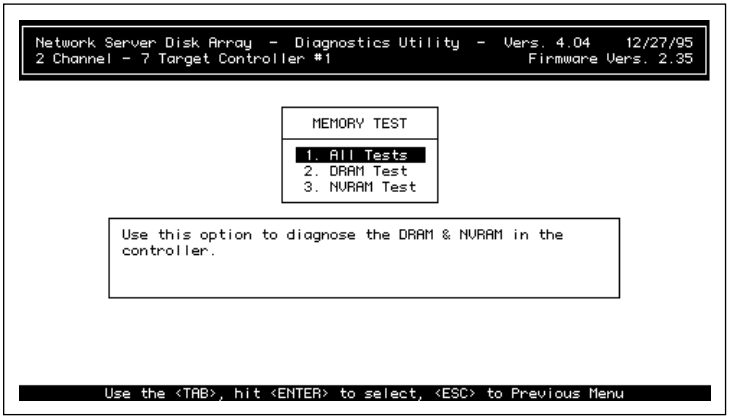
2 **Tab to highlight the test you want to run.**

A brief description of the test appears on the screen:



3 **Press Return.**

A subtest menu appears:



4 **Tab to highlight All Tests or the specific subtest you want to use.**

A brief description of each test or group of tests appears as you highlight it.

5 **Enter the number of times you want the utility to perform the test.**

6 **Press Return.**

The test begins, and a screen appears showing progress and results.

7 **When the test is complete, press any key to return to the Diagnostics Menu.**

If the board passes the test, you can exit from the utility, perform other board diagnostics, or proceed to the disk diagnostics. To get help if the board has failed a test, see “Obtaining Service and Support,” later in this chapter.

Running disk diagnostics

Disk diagnostics include the following:

- A non-destructive I/O test that tests reads from one or more disks.
- A destructive I/O test that tests both reads and writes.
- A diagnostic self-test that measures the disk against its specifications.
- A disk information probe that gives the brand, type, and size of any hard disk or non-disk SCSI device in the array.

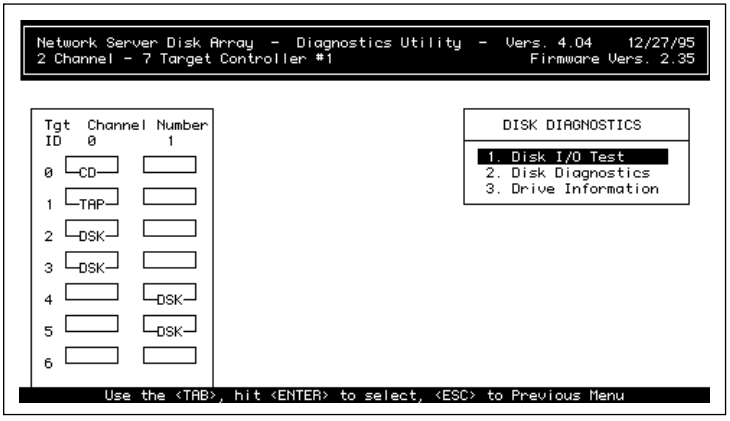
> **WARNING** Perform a full backup before running either of the disk I/O tests. Data is at risk with the non-destructive test and will be overwritten by the destructive test.

Running disk I/O tests

The procedures for running the destructive and non-destructive disk I/O tests are essentially the same:

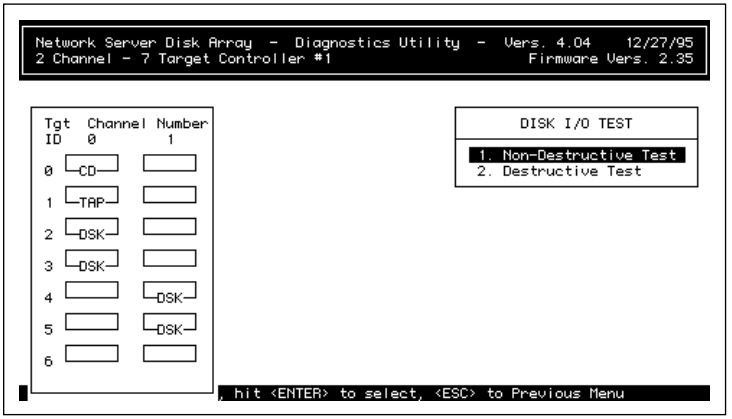
1 **In the Diagnostics Menu, tab to highlight Disk Diagnostics and press Return.**

The Disk Diagnostics menu appears:



2 **Press Return.**

The Disk I/O Test menu appears:



3 **Tab to highlight either the destructive or the non-destructive test and press Return.**

The first disk in the display at the left is highlighted.

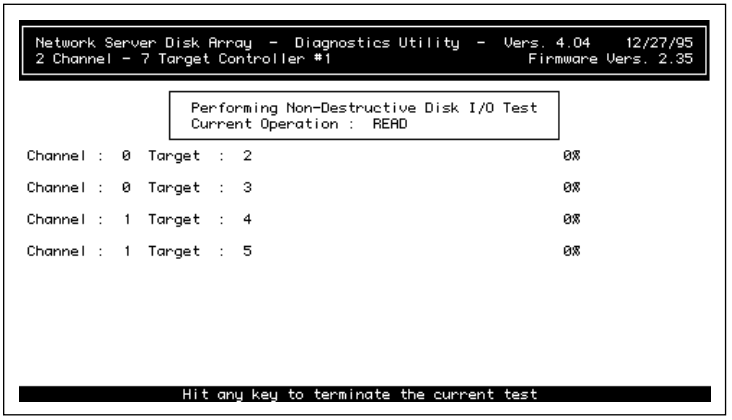
4 **Press Return to select the highlighted disk for testing, or tab to the disk you want to test and press Return.**

5 **Repeat step 4 until all disks have been selected.**

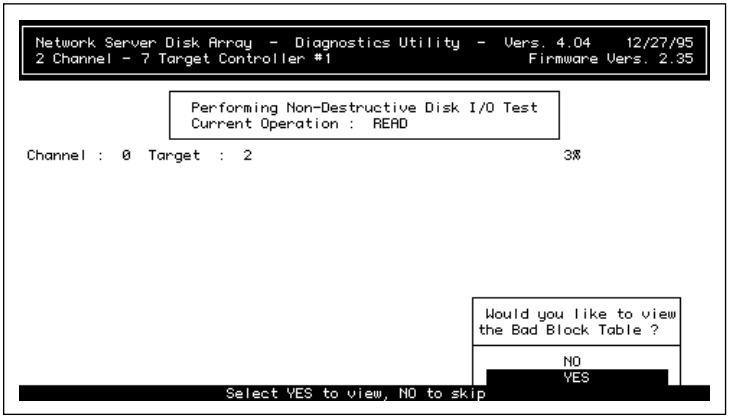
Non-disk devices, such as CD-ROM or tape drives, cannot be tested.

6 **Press Escape to start testing.**

A screen shows the test in progress:



When the test has been completed or terminated, a dialog box appears asking if you want to view the Bad Block Table. The Bad Block Table, discussed earlier in this chapter, allows you to isolate problems further.



7 **Tab to highlight Yes to view the Bad Block Table or No to end the test and press Return.**

If the disks pass the I/O tests, you can exit from the utility, perform other disk tests, or return to board diagnostics. If a disk fails the test, study the Bad Block Table and make a note of the specifics. To get help, see "Obtaining Service and Support," later in this chapter.

Running disk self-tests

The self-tests assess the disk according to its manufacturer's specifications. What the tests contain and what passing or failing means varies by disk make and model.

The steps to run self-tests are almost the same as the steps to run I/O tests:

1 **In the Diagnostics Menu, tab to highlight Disk Diagnostics and press Return.**

2 **In the Disk Diagnostics menu, tab to highlight Disk Diagnostics and press Return.**

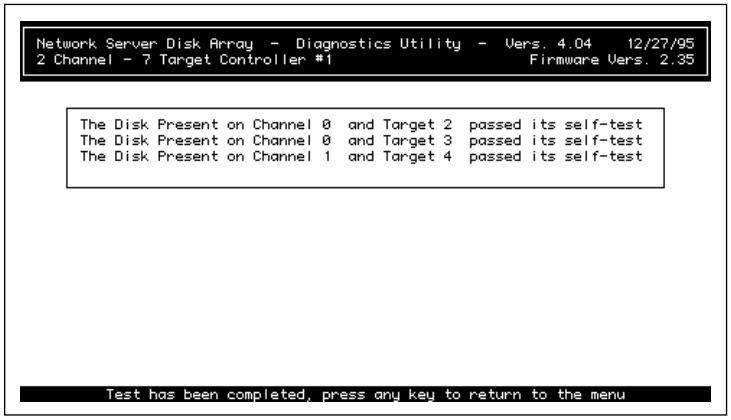
The first disk in the matrix at the left is highlighted.

3 **Press Return to select the highlighted disk for testing, or tab to the disk you want to test and press Return.**

4 **Repeat step 3 until all disks have been selected.**

5 **Press Escape to start testing.**

A test progress screen appears:



If the disks pass their self-tests, you can exit from the utility, perform other disk tests, or return to board diagnostics. If a disk fails its self-test, make a note of the specifics. To get help, see “Obtaining Service and Support,” later in this chapter.

Reviewing drive information

The drive information feature is not actually a test. Rather it is a way to find out the manufacturer, model, model number, and size of a disk. To use this feature follow these instructions:

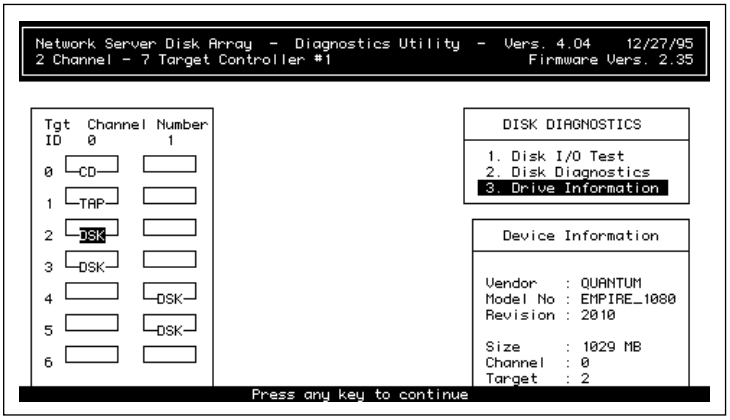
1 **In the Diagnostics Menu, tab to highlight Disk Diagnostics and press Return.**

2 **Tab to highlight Drive Information and press Return.**

The first disk in the display at the left is highlighted.

3 **Press Return to see information on the highlighted disk, or tab to the disk you want information on and press Return.**

A screen similar to the following appears:



4 **Repeat step 3 to see information on additional devices.**

You can see information for any hard disk or non-disk device in the controller, one disk or device at a time.

Obtaining service and support

The *Resource Guide*, packaged with your Network Server, includes phone numbers and other information that can help you solve problems that may come up with your Network Server PCI RAID Disk Array Card or with the Network Server itself. The *Resource Guide* is the best place to begin looking for assistance.

In addition to the *Resource Guide*, there is a great deal of continuously updated technical information available on the Internet. Go to *http//www.apple.com* to learn more.

Your Apple-authorized Network Server dealer is also available for information, warranty support, supplies, and repairs.

5 Administering the Disk Array With the Disk Array Manager

The Network Server PCI RAID Disk Array Manager is an AIXwindows application that provides monitoring and management facilities that you can use while the Network Server is running. For every controller installed in the Network Server, the application provides a graphical view of the condition of physical disks, system drives, and the controller itself, along with statistical profiles and a running log. The application's management features include the ability to take disks online or offline, to create hot spares, and to initiate rebuilds when disks are damaged.

Installing the Disk Array Manager

The Network Server PCI RAID Disk Array Manager is supplied on a CD-ROM disc that includes both the Disk Array Manager software and the driver software for the controller card. The installation process given here uses the AIXwindows version of the SMIT installation utility. You can also install the software from the AIX command line using essentially the same procedure but from a text-based interface. To install the software, follow these instructions:

1 **Make sure that you are logged into AIX as root.**

If you are not logged as root, follow these instructions:

1. At the AIX prompt, type `shutdown -r` (if users are connected) or `reboot` (if no users are connected) and press Return.
2. When the AIX login screen appears, log in as root.

2 **Insert the Disk Array Manager CD-ROM disc in the CD-ROM drive of the Network Server.**

3 **Open a dterm terminal window from the Common Desktop Environment.**

If you need more information about AIXwindows or the Common Desktop Environment, see Chapter 4, "Using AIXwindows and the Common Desktop Environment," in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

Complete AIX documentation is available online through the InfoExplorer application. For more information on InfoExplorer, see Chapter 5, "Using InfoExplorer to Retrieve Information," in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

4 **Type the following command at the dterm prompt and then press Return:**

```
smit install
```

The SMIT installation utility opens.

5 **Click the Install and Update Software button.**

The Install and Update menu appears.

6 **Click the Install/Update Selectable Software (Custom Install) button.**

The custom installation menu appears.

7 **Click the Install/Update From All Available Software button.**

An Input Device dialog box appears.

8 **Type the following information in the input device text box and then click OK:**

```
/dev/cd0
```

If your CD-ROM drive is not SCSI ID 0, substitute the correct number for the 0. After you click OK, the All Available Software dialog box appears.

9 **Type following information in the Software to Install text box and then click OK:**

```
all_licensed
```

A confirmation dialog box appears.

10 **Click OK.**

Installation begins, and a progress message appears. When the screen stops displaying new information, installation is complete.

11 **Exit from SMIT by choosing Exit SMIT from the Exit menu.**

12 **Reboot the Network Server and log in as root to start the Disk Array Manager.**

Starting the Disk Array Manager

The Disk Array Manager should always be running when the disk array is being used. Thus it should be set up to run as a background process. In addition, you need to log in to AIX as root, rather than with your user name.

The command syntax to launch the Disk Array Manager is as follows:

```
[nohup] dacmgr [-m <address>] [&]
```

- `dacmgr` is the basic command. Typing `dacmgr` at the AIX prompt and pressing Return launches the application.
- The `[nohup]` option allows you to close the dterm window from which you launched the Disk Array Manager without closing the Disk Array Manager itself. If you don't include this option, you must keep the dterm window open whenever you are running the Disk Array Manager. This may or may not be of importance to you.
- The `[-m <address>]` option allows the Disk Array Manager to send you mail informing you of significant events that require your attention. For more information about mail, see "Getting Mail," later in this chapter.
- The `[&]` option sets the Disk Array Manager to run in the background. You should always include this option.
- The `[-display <display>]` option displays the Disk Array Manager on a remote X server as well as on the Network Server monitor. For more information, see "Using the Disk Array Manager on a Remote X Server," later in this chapter.

Note: Do not type the brackets, either standard ([]) or angle (<>). Specific information must be substituted within the angle brackets. For example, you would type `dacmgr -m adminstrator &` if you wanted to get mail and your E-mail address were administrator.

If you have not yet set up mail service, or if you don't know whether or not you need to close the dterm window or monitor the Disk Array Manager from an X server, you can add these options at any time. Simply quit the Disk Array Manager and then relaunch it with the correct command. To launch the Disk Array Manager as a background process, follow these instructions:

1 **Log in as root if you have not already done so.**

If you are logged in under your user name, do the following:

1. Restart the Network Server by typing `shutdown -r` (if users are connected) or `reboot` (if no users are connected), and then pressing Return.
2. When the AIX login screen appears, log in as root.

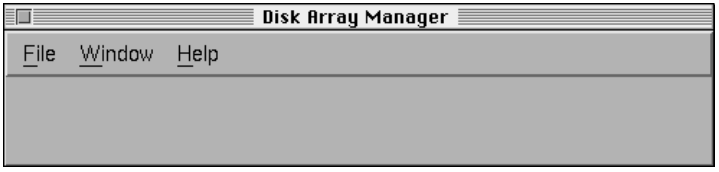
2 **Open a dterm terminal window from the Common Desktop Environment.**

3 **Enter the following command and press Return:**

```
dacmgr &
```

The menu bar

After you open the Disk Array Manager, the application's main window appears. The menu bar floats above it:

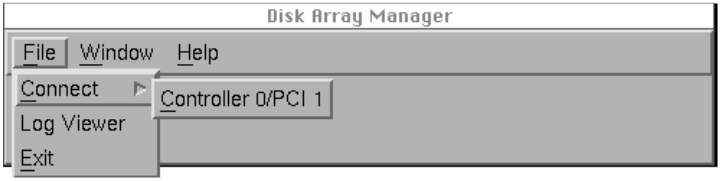


If you click the Window Manager menu button, at the left end of the menu bar, the Window Manager menu opens. The menu items are the same as for all AIXwindows applications. Clicking Minimize reduces the Disk Array Manager to an icon, which you can quickly open at any time. This can be very useful because of the need to run the application continuously.

For more information on using the Window Manager to manipulate windows, see Chapter 4, “Using AIXwindows and the Common Desktop Environment,” in *Using AIX, AppleTalk Services, and Mac OS Utilities on the Apple Network Server.*

There are three menus for the Disk Array Manager itself: File, Window, and Help.

The File menu contains three commands—Connect, Log Viewer, and Exit:

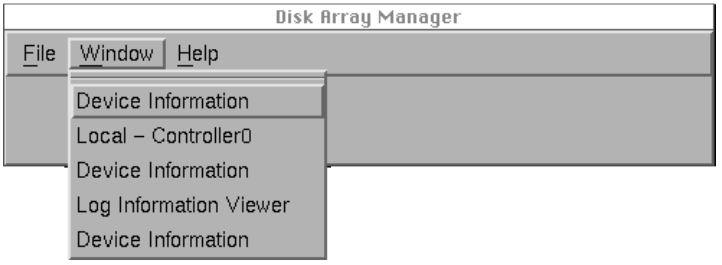


The Connect command lets you open a Disk Array Manager window for any controller installed in the Network Server, as well as to switch back and forth between windows for other controllers.

The Log Viewer command opens the Log Information Viewer window, described in “The Log Information Viewer,” later in this chapter.

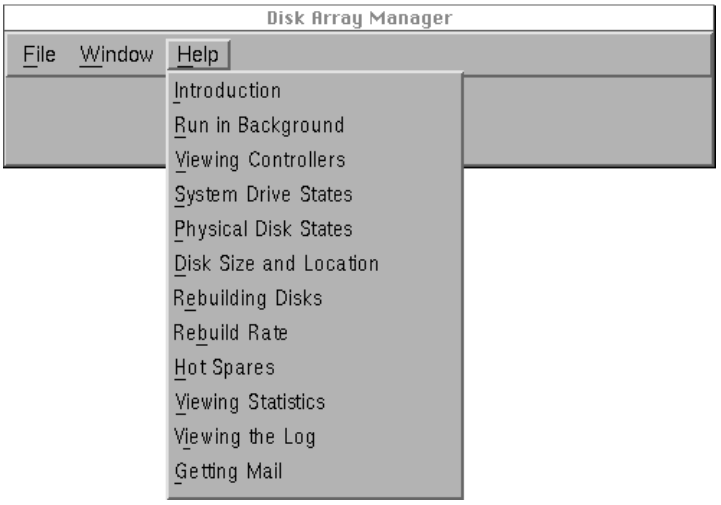
The Exit command lets you exit from the Data Access Manager.

The Window menu allows you to move between open windows:



If no windows are open, the menu has no commands in it.

The Help menu gives you access to an online help file:



Click any of the listed subjects to go to that section of the help file.

Using the Disk Array Manager's main window

If you have more than one Network Server PCI RAID Disk Array Card installed, the main window for the card in the first (lowest numbered) slot appears by default. If you want to see the window for another controller, do this:

1. **Choose Connect from the File menu.**
2. **Choose the controller you want to monitor from the submenu that appears.**

Regardless of which controller's window is displayed, the Disk Array Manager monitors all installed controllers simultaneously. You can switch from one controller's main window to another controller's main window at any time.

The following figure shows the main window for a typical controller:

The main window gives a general picture of the size, layout, and health of the disk array. System drives are represented on the right, the physical disk array on the left. The circuit board icon at the upper right represents the controller itself.

System drive information in the main window

Eight system drive icons are always displayed (eight being the maximum any controller can support) but only those icons that are green, yellow, or red have actually been configured to be part of the array. The colors can be interpreted as follows:

- Green means the system drive and all its constituent physical disks are fully functional.
- Yellow means the system drive is in critical condition, but that no data has been lost. More specifically, it means that the system drive is redundant (of RAID level 1, 5, or 6) and that one of its disks has failed.
- Red means that data may have been lost. If the system drive is of RAID

The indicator lights in the graphic on screen do not match exactly the indicator lights on the Network Server or on an external enclosure. They translate roughly as follows:

Condition	Light in graphic	Light on array
Ready for read or write	Green	Steady light green
Read or write in process	Green	Flashing bright green
Failed drive	Red	Steady red
Undergoing rebuild	Yellow	Flashing orange
Supplying data for rebuild	Green	Flashing bright green
Unconfigured	White	Steady light green

Note that if all indicator lights in an array are red, it does not usually mean that all disks have failed. Instead it usually indicates that the computer is resetting the SCSI bus.

The position of disks in the graphic indicates their channel and SCSI ID. All disks in the left hand tower are on channel 0; all disks on the right are on Channel 1. The towers represented on screen correspond to the two channels of the Network Server, but the single tower in the Network Server itself includes both channels.

The disk numbers correspond to their channel and SCSI ID numbers. The hot spare in this example, therefore, is disk 1, 6. In a Network Server, it would be in the lowest front drive bay.

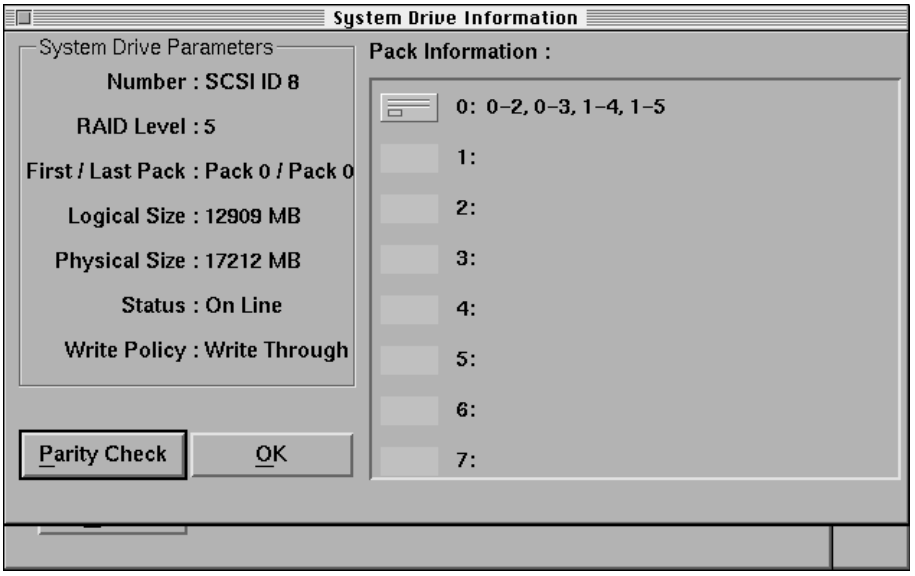
The total size represents the disk capacity of all disks configured into a system drive. It does not include hot spares.

Controller information in the main window

The circuit board icon representing a controller is simply an icon. It does not in itself provide any information. When you double-click the icon, the Controller Information window, discussed later in this chapter, appears.

Using the System Drive Information window

If you double-click a configured system drive in the main window, a System Drive Information window for that system drive appears:



The System Drive Information window allows you to view the system drive's structure and to monitor its state. The parity check option allows you to check and reset parity for those RAID levels that support it.

Using System Drive Parameters and Pack Information

System Drive Parameters, on the left of the window, identify the characteristics and state of the system drive.

Note that the SCSI ID equals the system drive's identifying number plus eight, or 0+8 in this example. This is the SCSI ID that the controller assigns to the system drive for the operating system to see.

The status parameter can be online, critical, or dead, corresponding to the green, yellow, and red states of icons in the main window.

All the other parameters—RAID level, included packs, size, and write policy—are those that were set for the system drive using the configuration utility.

Pack Information, on the right of the window, shows a disk icon for each system drive, of which there is only one in this example. The number before the colon is the system drive ID. The numbers after the colon give the channel and SCSI ID for each physical disk used in the system drive. Channel and SCSI ID numbers are separated by a dash, disks in the pack by commas.

Using the parity check

If parity errors are reported for a disk, you can run the parity check to analyze and possibly correct those errors. The parity check is only available for system drives of RAID levels 1, 5, and 6. To run the parity check do this:

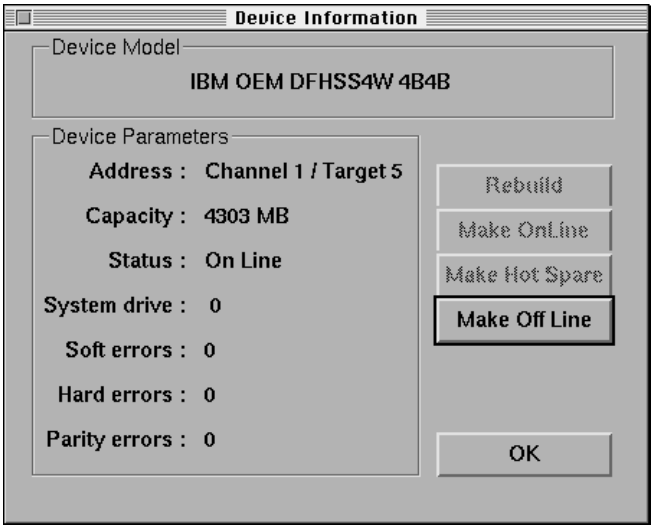
- **Click the Parity Check button in the lower left corner of the System Drive Information window.**

A screen similar to the following appears.

This is a fairly lengthy and processor-intensive test, but it can in many cases restore parity to the system drive and thus eliminate a potential threat to the data and software the system drive contains.

Using the Device Information window

If you double-click a disk icon in the main window, a Device Information window, specific to that disk, appears:



The top window bar gives the disk's manufacturer, name, and model number. The Device Parameters section on the left of the window provides information on the disk's location, size, status, and system drive. The error counts provide the same information as do the error counts maintained by the Configuration Utility. Viewing error counts through the Disk Array Manager has the advantage that you do not need to shut down the server.

The buttons on the left indicate the four states a disk can be in: online, offline, unconfigured hot spare, or rebuilding. In this example, showing a functional member of a pack and system drive, only the Make Offline button is active.

Taking a disk offline

If a disk fails or is removed, it goes offline automatically. Taking a disk offline, also known as killing a drive, should be done only when a drive needs to be repaired or replaced—in other words when you think it is going to go offline soon anyway, perhaps due to the number and kinds of errors showing up in its Device Information window.

> **WARNING** Depending on the RAID level of the system drive, taking a drive offline may result in data loss. Before taking a drive offline, make sure that a hot spare is available, or that the array is inactive.

To take a drive offline, do this:

- **Click Make Off Line in the Device Information window.**

  A dialog box appears after a short interval, telling you that the disk has been made offline, and asking you to confirm the operation. If you click Yes, the disk's status changes to offline and the Rebuild button becomes active.

  In the main window, the disk's drive light changes to red and a red X appears on the disk.

Rebuilding on replacement disks

Rebuilding on a replacement disk means writing data and parity information from other disks in the array to the replacement disk. Rebuilding is restricted to disks in redundant (fault-tolerant) arrays, which are arrays at RAID levels 1, 5, or 6. If the array contains a hot spare (standby disk), rebuilding is automatic. If there is no hot spare, you can remove the damaged disk and replace it with another disk of the same SCSI ID and of equal or greater capacity.

If the disk array supports hot-swapping and is AEMI-compliant, as the internal disk array in the Network Server is, rebuilding starts automatically when you install the replacement disk. If the disk array does not support hot swapping or is not AEMI-compliant, you can manually initiate rebuilding after you install the replacement disk. Use the following instructions to replace the disk and to initiate rebuilding:

Replacing a disk

IMPORTANT If your disk array does not support hot swapping, shut down the Network Server before rebuilding. Steps 1 and 2 are not necessary as the computer has been shut down. Follow the instructions from step 3. After step 4, reboot and start the Configuration Utility. For more information see "Starting the Configuration Utility," earlier in this chapter.

1 **Shut down the damaged disk.**

To shut down a disk in an internal drive bay of the Network Server, pull back the drive tray eject lever on the drive bay. To shut down a disk in an external array, follow the directions in the user's guide that came with the external array.

2 **Wait 30 seconds.**

This gives the disk time to spin down completely. It also gives the controller time to recognize that the damaged disk has been removed and to prepare to recognize the replacement disk.

3 **Remove the damaged disk.**

To remove a disk from an internal drive bay of the Network Server, pull the drive tray towards you until the tray comes free. To remove a disk from an external array, follow the directions in the user's guide that came with the external array.

4 **Install a disk of equal or greater capacity and the same SCSI ID as the damaged disk in the drive bay from which you removed the damaged disk.**

To install a disk in an internal drive bay of the Network Server, follow the directions in *Setting Up the Network Server.* To install a disk in an external array, follow the directions in the user's guide that came with the external array. If you are using an Apple-supplied disk in an internal drive bay of the Network Server, the SCSI ID is set automatically.

Rebuilding a disk

Manual rebuilding is necessary if your disk array does not support hot-swapping, or is not AEMI-compliant.

> **WARNING** Although it is possible to rebuild a damaged disk with the Disk Array Manager, it may not work and it is not recommended. If you need to rebuild a damaged disk, it is much safer to initiate the process through the Configuration Utility, and then only after low-level formatting the disk.

Follow these instructions to initiate rebuilding:

1. **Open the Device Information Window for the replacement disk.**
2. **Click Rebuild.**

The Rebuild screen appears, giving you the progress of the rebuilding:

Depending on the size of the disk, rebuilding can be a lengthy process. While rebuilding is underway, the disk's indicator light in the main window changes to yellow, and a yellow upward pointing arrow appears on the disk. Once rebuilding is complete you can make the disk online.

Making a disk online

Making a disk online brings it to full operational status within the array. This is dangerous if the disk is faulty. You should reserve this operation for disks that have been successfully rebuilt, or for disks which you have good reason to believe have nothing wrong with them. This latter category might include, for example, disks that were removed from the disk array for some reason, but that had previously been functioning well. To make a disk online, do this:

1 **Click Make On Line in the Device Information window.**

After a short interval a dialog box appears, telling you that the disk has been made online and asking you to confirm the operation.

2 **Click Yes.**

The disk's status changes to online and all buttons except for Make Offline are inactivated. In the main window, the disk's indicator light changes to green.

Making a hot spare

If you have removed a damaged drive and an existing hot spare has been used for rebuilding, you can add a new hot spare as follows:

1 **Make sure the hard disk to be used has a capacity equal to or greater than that of the other disks in the array.**

2 **Set the disk's SCSI ID to match the SCSI ID of the damaged disk that has been removed.**

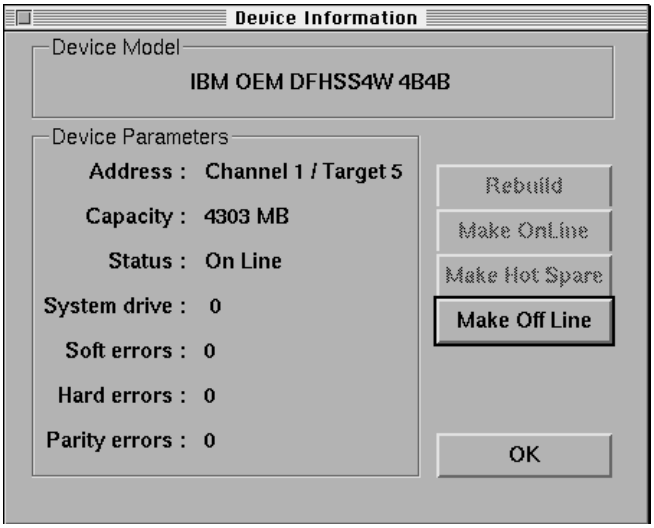
If you are inserting an Apple-supplied hard disk into an internal drive bay of the Network Server, it is not necessary to set the SCSI ID.

3 **Insert the disk into the drive bay formerly occupied by the damaged disk.**

4 **Locate the new disk in the main window of the Disk Array manager.**

The new disk has a white drive light, indicating that it has not been configured.

5 **Double-click the disk icon to open its Device Information window:.**



6 **Click Make Hot Spare.**

After a short interval, a dialog box appears, telling you that the disk has been made into a hot spare, and asking you to confirm the operation.

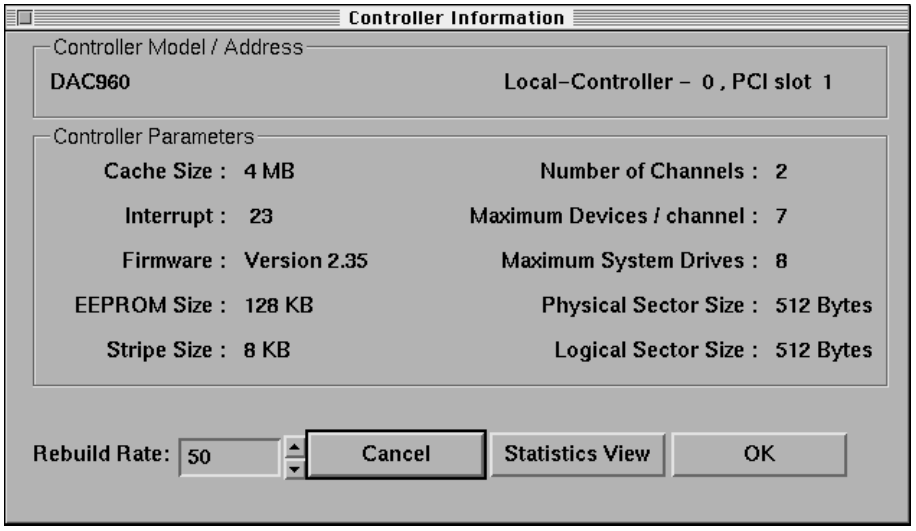
7 **Click Yes.**

The disk's status changes to hot spare and all buttons become inactive.

In the main window, the disk's drive light changes to green and a white cross appears on the disk icon.

Using the Controller Information window

The Controller Information window allows you to monitor the condition of a controller as well as to view statistics for the array it controls:

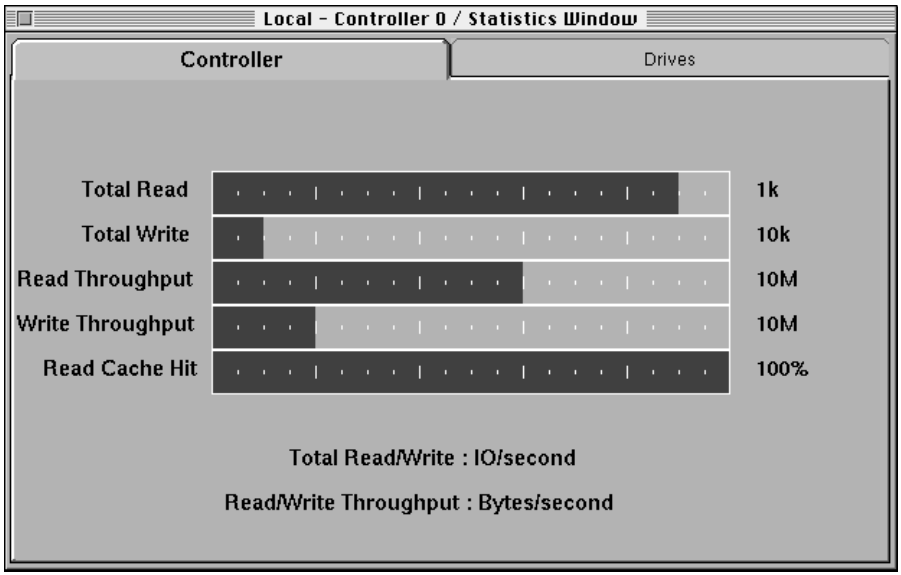


The top bar gives the name, number, and PCI slot of the controller whose specifications are displayed as follows:

Parameter	Definition
Cache Size	Amount of DRAM available for caching
Interrupt	The type of interrupt in use
Firmware	The version of firmware in the controller
EEPROM size	Size of EEPROM firmware control program
Stripe size	Amount of data written in a single stripe
Number of channels	The number of SCSI channels this controller supports
Maximum devices/channel	The maximum number of SCSI devices that can be attached per channel
Maximum System Drives	The maximum number of system drives that can be defined
Physical Sector Size	The size of a sector on a physical disk
Logical Sector Size	The size of a sector on a system drive

The rebuild rate can be adjusted by clicking the up or down arrows next to the Rebuild Rate value in the lower-left corner of the window. The rebuild rate is defined as the percentage of time the controller spends reconstructing data on a new disk from redundant data stored on the array. Values range from 0 to 50. A high value instructs the controller to spend a maximum amount of time reconstructing the data (and less time servicing system requests). A low value reverses those priorities to spend more time processing system activity and less time rebuilding the array. Rebuilding is discussed in detail in "Rebuilding a Disk," earlier in this chapter.

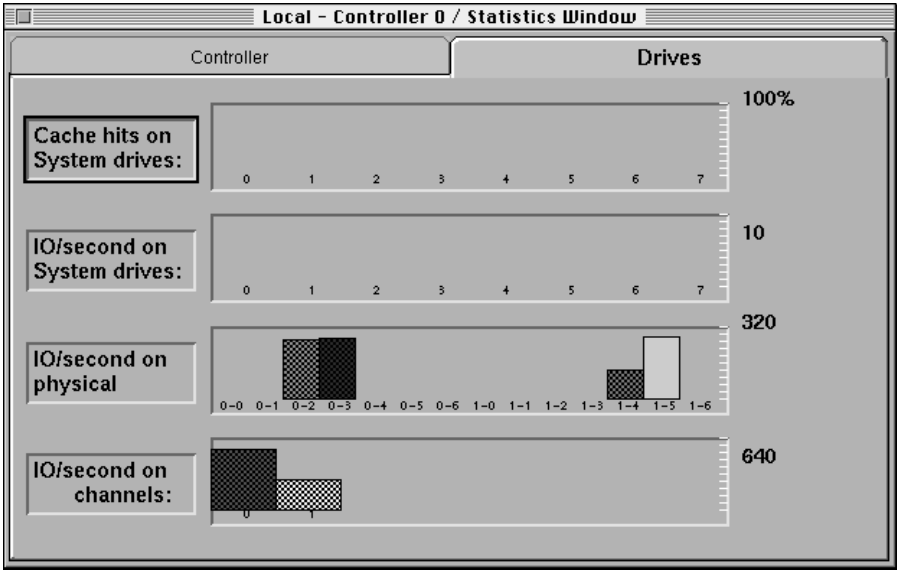
If you click Statistics View, the Statistics View window appears:



Statistics are updated at standard intervals, and the values are a numerical average of the data collected during the time since the last update. The data reported is as follows:

- Total Read: Total number of disk input operations per second on all disks
- Total Write: Total number of disk output operations per second on all disks
- Read Throughput: Amount of data read from the disk array per second
- Write Throughput: Amount of data written to the disk array per second
- Read Cache Hit: Percentage of read operations handled by cache memory

The Statistics View window provides statistics about both the controller itself and the physical disks, system drives, and channels in the array. If you click the Drives tab, the following window appears:

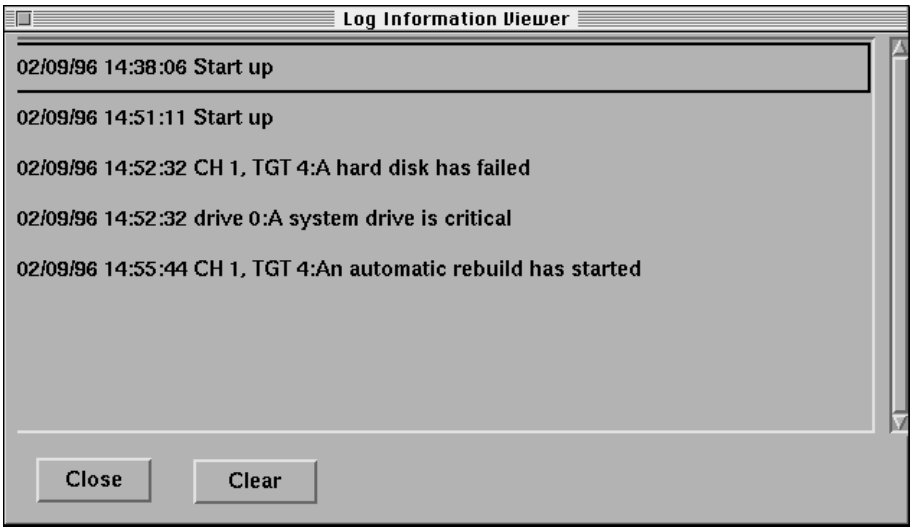


The data in this window is as follows:

- Cache hits on system drives: The percentage of reads that are serviced by cache memory
- IO/second on system drives: The number of input/output requests per second made to a system drive
- IO/second on physical: The number of input/output requests per second made to a physical disk
- IO/second on channels: The number of input/output requests per second made on a specific controller channel

The Log Information Viewer

The Log Information Viewer, a sample of which is shown in the following figure, lets you see information from a log file, which keeps a running record of all controller events in a session. (The log file is automatically cleared whenever the Disk Array Manager shuts down.)



The log file helps you analyze controller use and also helps you pinpoint the time of errors and the events leading up to them. Further, the log file can be used to form mail messages, as discussed in the next section.

Getting mail

In many or most instance, you won't be working on the Network Server directly. To make it easier to track the condition of the disk array, the Disk Array Manager can send mail to you at any address you specify.

Before you can receive mail, however, the AIX sendmail process must be configured. If yours is an existing installation, this has probably already been done. If you're not sure, contact the network administrator. If you need to configure or learn more about sendmail, you can access its documentation through InfoExplorer.

Once sendmail has been configured, setting up mail service is easy:

1. **Quit the Disk Array Manager by choosing Exit from the File menu.**
2. **Open a dterm terminal window from the Common Desktop Environment.**
3. **Enter the following command:**

   ```
   dacmgr -m <address> &
   ```

   For <address>, substitute the address at which you want to receive mail.This can be your normal electronic-mail address, or any other e-mail address that you can use. Once mail service is up and running, the Disk Array Manager will notify you of any events requiring your attention.

   Note: Be sure to include any other required options in the startup command, such as `[nohup]`, discussed in "Starting the Disk Array Manager," earlier in this chapter, or `[ -display <display>]`, discussed next in "Using the Disk Array Manager on a Remote X Server." Always include the ampersand (`&`).

4. **Press Return.**

   The Disk Array Manager starts up, this time configured to receive mail.

Using the Disk Array Manager on a remote X server

You can use the Disk Array Manager on a remote X server. The display appears both on the remote server and the Network Server. All monitoring and administration features are available from either computer.

Before you begin, make sure that the X server is properly set up to communicate with the Network Server. Check with your network administrator and see the documentation that came with your X server software. Follow these instructions to use the Disk Array Manager on a remote X server:

1. **Quit the Disk Array Manager by choosing Exit from the File menu.**
2. **Open a dterm terminal window from the Common Desktop Environment.**
3. **Enter the following command:**

   ```
   dacmgr -display <display> &
   ```

   For `<display>` substitute the machine name, a colon (:), the display number, a dot (.) and, finally, the screen number. The machine name is either the IP address or the name of the X server as listed in the domain name server. The display number is always 0. The screen number depends on the number of monitors attached to the X server and the way the X server software numbers monitors. The screen number is always 0 if only one monitor is attached. See the documentation that came with your X server software for more information. Use the following example as a model, noting that there are no spaces after the colon or between the display number and the screen number:

   ```
   dacmgr -display market7:0.0 &
   ```

   Note: Be sure to include any other required options in the startup command, such as `[nohup]`, discussed in "Starting the Disk Array Manager," earlier in this chapter, or `[ -m <address>]`, discussed in “Getting Mail” (next). Always include the ampersand (`&`).

4. **Press Return.**

   The Disk Array Manager starts up, displayed on both the Network Server and the remote X server.

Getting help

You can access an online version of this chapter at any time from within the Disk Array Manager application. To do so, follow these instructions:

1. **Pull down the Help menu from the Window menu bar.**
2. **Drag to the subject you want information on and release the mouse button.**

   The text appears in a scrollable window.

Appendix A Specifications

This appendix lists the physical and electronic specifications of the Network Server PCI RAID Disk Array Card.

Controller	DAC960PL
CPU	Intel i960® RISC 32-bit microprocessor
Clock Rate	25 MHz
Memory Module Type	DRAM, 72-pin SIMM, 70 ns or faster Size: Minimum: 2 MB Optional: 4, 8, 16, or 32 MB (n x 36)
Cache Type	Write: selectable, write through or write back Read: Always enabled
Firmware	ROM Type: Flash EEPROM, 256K x 8
PCI I/O Processor	Mylex 189206 ASIC Bus Type: 32-bit, 33 MHz, PCI Local Bus Mode: Bus Master Transfer Rate: Up to 132 MB/second (burst)
SCSI I/O Processors	NCR 53C720, one per channel Bus Type: 8 or 16-bit Fast / Wide SCSI-2 compliant Transfer Rate: Up to 20 MB/second per channel Up to 60 MB/second, 3 channels
RAID Levels supported	RAID 0, striping RAID 1, mirroring RAID 5, parity RAID 6 (0+1), striping and mirroring RAID 7 (JBOD), single-drive control

Appendix B Interpreting and resolving error messages

When an problem condition is reported to a Network Server PCI RAID Disk Array Controller, the controller software—either the Configuration Utility, the Diagnostics Utility, or the Disk Array Manager—displays an error message reporting the difficulty. Some conditions can be easily corrected, while others may require reconfiguring the array or replacing equipment. The information in this appendix can help you better understand why an error message occurred and what you can do to solve the problem.

Error messages reported by the configuration and diagnostics utilities

The following messages indicate problems that must be solved before you can continue using the disk array the message refers to. Try the suggested solution. If it does not work, you may need to reconfigure the disk array or fix a hardware problem.

Adapter not responding to commands. Cannot proceed further. Verify setup and try again.

Shut down the system and check that all cables are properly connected and that the card itself is properly installed. Reboot and launch the Configuration Utility. If the problem persists, run the board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

All or some of the system drives created in this session have not been initialized. This may cause unpredictable system behaviour.

Initialize any system drives that have not been initialized.

Asynchronous Rebuild Failed.

Rebuilding failed because more than one disk was offline. Run disk diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4. You may need to reformat or replace one or more disks.

Cannot continue with rebuild as failed to start the disk.

Run disk diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4. You may need to reformat or replace one or more disks.

Cannot make disk online as this disk has been probably replaced by a standby disk. It is no longer a part of any system drive.

Run disk diagnostics to ascertain if the disk is in good working order. If the disk is operational, you can bring it online by including the disk in a pack and then in a system drive. For information on adding packs and system drives, see "Viewing and Updating the Current Configuration," in Chapter 4.

Cannot rebuild this disk as it is part of a non-redundant system drive.

Only disks included in system drives of RAID levels supporting redundancy can be rebuilt.

Cannot rebuild this disk as this physical disk has probably been replaced by a Standby disk. It is no longer a part of any System drive.

Run disk diagnostics to ascertain if the disk is in good working order. If the disk is operational, you can bring it online by including the disk in a pack and then in a system drive. For information on adding packs and system drives, see "Viewing and Updating the Current Configuration," in Chapter 4.

Check failed. To restore consistency, rerun the check with automatic restoration enabled.

Rerun as directed.

Checksum error.

Try the following:

1. Save the configuration to a floppy disk, as described in "Backing Up the Configuration," in Chapter 4.
2. Reboot the computer.
3. Restart the Configuration Utility.
4. Restore the configuration using your backup copy.

Controller not found. Please verify setup and run the utility again.

Shut down the system and check that all cables are properly connected and that the card itself is properly installed. Reboot and launch the Configuration Utility. If the problem persists, run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

Corrupted configuration file. Cannot continue with restoring the configuration.

If you have a written description of the configuration to be restored, you can restore it from your notes.

Error in opening file. Cannot continue with backup.

Write down a description of the configuration to be backed up.

Error in opening file. Cannot continue with restore.

If you have a written description of the configuration to be restored, you can restore it from your notes.

Error in reading from floppy. Please verify whether the floppy is inserted properly.

Verify that the floppy disk is undamaged and try again.

Error in reading the configuration from FLASH. Cannot continue with backup.

Make a written description of the configuration to be backed up.

Error in writing configuration to controller.

There may be a problem with either the NVRAM or the EEPROM chip. Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

Error in writing to the floppy. Please verify the floppy is inserted properly.

Make sure that the floppy disk is a freshly-formatted Mac OS floppy disk.

Expected Disks Not Found.

Do the following:

1. Ensure that all devices are connected, turned on, and functioning properly.
2. Press any key.

   The screen that appears gives you the choice of pressing ESC or pressing S.
3. Press ESC or S.

   If you press ESC you can restart the Network Server to see if your inspection and correction of problems (such as devices being turned off or not plugged in) was successful. Go to step 3.

   If you press S the record of the damaged configuration is saved. You will need to configure the array from scratch after restarting the Network Server.

4. Reboot the Network Server by pressing the reset key on the front of the computer.

   If you pressed ESC and the Expected Disks Not Found screen does not reappear, check View/Update Configuration. If the configuration displayed there is functional, your work is complete. (Don't do step 4.)

   If you pressed ESC and the Expected Disks Not Found screen reappears, press S, and then reboot the Network Server. Go on to step 4.

5. Configure the Disk Array

   You need to do a complete configuration, following the directions in Chapter 3, just as though the array had never been configured. Low-level format any suspect disks, and run disk diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4. Replace any disks that can't be formatted or that fail their tests.

Failed to start device after formatting.

The disk may be faulty. Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Error reading Configuration from FLASH. Invalid status from adapter on Read FLASH configuration.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Error reading configuration.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Invalid device state in state table.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Invalid Pdrive Flag found.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Invalid RAID level found in computing size.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Invalid RAID level in configuration table.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Number of disks in current pack is 0 or greater than 8.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. NVRAM configuration error.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

FATAL ERROR. Unknown device type in Inquiry.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

Format Failed.

Replace the disk.

Initialization failed. Press any key to continue.

Run disk diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

Insufficient # of free entries in change list.

Reboot the Network Server.

Invalid channel number in field.

Check the channel number. For the Network Server, the channels are 0 and 1.

Making a DEAD drive ONLINE will enable Reads and Writes to that drive. This could have catastrophic effects if not used properly.

Only make dead disks online if you have good reason to believe that there is nothing functionally wrong with them.

Number of inconsistent blocks is more than 100. Restoring consistency doesn't assure consistency of the system drive.

Low-level format the disks in the system drive.

Restore consistency aborted as irrecoverable errors occurred.

Low-level format the disks in the system drive.

The current configuration does not match the stripe size. Cannot define system drives

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

The NVRAM and FLASH configurations do not match.

This condition results from a conflict in the configuration records stored in Non-Volatile RAM and in Extendable Eraseable Programmable Read-only Memory (EEPROM). EEPROM is also referred to as FLASH. To correct the condition, do the following procedure, which is based on the assumption that the EEPROM record is the more accurate:

1. Press any key to display the Load Configuration screen.
2. Select FLASH to view the configuration from that source.
3. Review the configuration, and decide if this copy should be saved to both FLASH and NVRAM.
   —To review NVRAM before making a decision, follow the directions on the screen.
   —To save the configuration, press S.

This option is not supported by the current Firmware version of the controller.

Make sure you have the latest firmware installed. Contact your Apple-authorized Network Server dealer for assistance.

This system drive has already been initialized.

Do not proceed with initialization.

WARNING !! Stripe size does not match with configuration. This may cause data loss if you choose to proceed further.

Run board diagnostics, as described in "Using the Diagnostics Utility," in Chapter 4.

Writing configuration to FLASH failed. Restore configuration failed.

If you have a written record of the configuration, you can do a manual restoration.

Error messages reported by the Disk Array Manager

Errors reported by the Disk Array Manager are coded according to severity:

- Level 0—catastrophic errors—are numbered from 1001 to 1100.
- Level 1—severe errors—are numbered from 1101 to 1200.
- Level 2—error—are numbered from 1201 to 1300.
- Level 3—warnings—are numbered from 1301 to 1400.

The number scheme allows condition type to be easily distinguished. There are only a few messages in each group. Informational messages numbered from 1401 to 1500 are not discussed here. These informational messages are self-explanatory and require no action by the user.

Level 0: catastrophic conditions

1001: **Controller is dead. System is disconnecting from this controller.**

Check the *Resource Guide*, packaged with the Network Server, for support information, or see your Apple-authorized Network Server dealer for service.

Level 1: serious conditions

1101: **Network connection error**

Try again. If the problem persists, check your physical network connection and your network setup in AIX. If this does not resolve the problem, contact your network administrator.

1103: **Power supply failed**

See your Apple-authorized Network Server dealer for service.

1104: **One controller has failed. Can't determine which one.**

Shut down AIX and run the disk diagnostics provided by the Diagnostics Utility. When the problem has been located, check your *Resource Guide* for support information, or contact your Apple-authorized Network Server dealer for service.

1105: **One system drive in array has been taken off-line**

Open the System Drive Information window in the Disk Array Manager to locate the system drive in question. Find out which disk or disks have failed. If the array is redundant (of RAID level 1, 5, or 6) and also contains a hot spare, rebuilding will have already begun. Otherwise, you can replace the problem drive. If more than one disk has failed, or if the array is not redundant, you will need to reconfigure the array.

1106: **One hard disk in array has failed**

Open the Disk Information window in the Disk Array Manager to locate the hard disk in question. If the array is redundant (of RAID level 1, 5, or 6) and also contains a hot spare, rebuilding will have already begun. Otherwise, you can replace the problem drive. Reconfigure the array if it is not redundant.

1107: **Temperature too high**

Shut down the Network Server. Check the room temperature and the operating condition of the server's fan. Replace the fan if necessary.

Level 2: error conditions

1201: **One system drive in array is critical**

Open the System Drive Information window in the Disk Array Manager to locate the system drive in question. Find out which disk has failed. If the array is of RAID level 0, 5, or 6, and also contains a hot spare, rebuilding will have already begun. Otherwise, you can hot swap a new drive.

1202: **Failed to create the local log file**

Try again. If the problem persists, exit from and restart the Disk Array Manager.

1204: **Failed to create log information window**

Try again. If the problem persists, exit from and restart the Disk Array Manager.

1206: **Failed to create more windows**

Try again. If the problem persists, exit from and restart the Disk Array Manager.

1207: **Statistics Date Event handler problem, can't start performance window**

Try again. If the problem persists, exit from and restart the Disk Array Manager.

1209: **Rebuild physical disk stopped with error**

Exit from AIX and run the Diagnostics Utility to check on the condition of the disk. If the disk is faulty, replace it.

1210: **Rebuild system drive failed**

Exit from AIX and run the Diagnostics Utility to check on the condition of all disks. If a disk is faulty, replace it.

1211: **Parity check on system drive error**

A problem may be developing with one or more disks in the system drive. If the error message comes up again, exit from AIX and run the Diagnostics Utility to check on the condition of all disks in the system drive. If a disk is faulty, replace it.

Reasons why disks are taken offline

Disks may be reported as DED (“dead”—that is, offline) in the Configuration Utility or Offline in the Disk Array Manager for a variety of reasons:

- SCSI Sequence Error

  Whenever a device follows an illegal SCSI phase sequence (for example, if a disk is unexpectedly disconnected), the controller resets the SCSI bus and then interrogates all the disks it expects to be there. If all the disks respond, operation continues. If any disk fails to respond, the controller takes that disk offline.

- SCSI Busy Status

  When a disk reports itself as busy when the controller gives it a command, the controller retries the command. If the disk stays busy for more than forty-eight seconds, the controller takes the disk offline.

- Timeout on a command

  If a disk does not complete a command issued to it within six seconds, the controller resets the SCSI bus, interrogates the disk, and takes the disk offline if the disk does not respond.

- Media error recovery flow:

  If a disk in a redundant array reports a media error during a read command, the controller reconstructs the data from the other disks in the array. It then writes the data to a different area of the disk. The data is read from the new location for verification. If the data cannot be verified, the controller reads the data to another sector and tries again. If this attempt fails, the controller takes the disk offline.

- SCSI Reset interrogation

  Whenever an error requiring a SCSI reset is reported, the controller issues a series of commands to each disk as it starts up. The disk has three seconds to respond to each command. If time runs out, or if an unrelated error is reported during this interrogation, the controller takes the drive offline.

- User command

  A disk can also be taken offline by the user either through the Configuration Utility or the Disk Array Manager.

Glossary

availability The relative ability of a *disk array* to make its data available despite the failure of one or more of the disks in the array. See also *fault tolerance* and *redundancy.*

asynchronous Not linked in time. Asynchronous operations can overlap in time.

board See *card.*

bus See *channel.*

cache A portion of computer memory that is set aside for temporary data storage, thus reducing demands on the CPU.

card A circuit board that is installed in a computer to provide a specific function that the computer itself does not provide. In this case, the Network Server PCI RAID Disk Array Card provides a RAID controller. Also known as an *expansion card,* or a *board.*

channel An electrical path for the transfer of data and control information. Also known as a *bus.*

cold swapping Removing a damaged disk and replacing it with a new disk of the same or greater capacity and the same SCSI ID while the Network Server and all connected external arrays are shut down. Cold swaps are not required in the Network Server itself. See also *hot swap.*

configuration The way in which the physical disks are arranged into *packs* and then into *system drives* to become part of a disk array.

controller The RAID hardware, including the CPU, DRAM, and firmware as supplied on the Network Server PCI RAID Disk Array Card.

disk array A group of hard disks that has been configured by and is under the control of the Network Server PCI RAID Disk Array Controller.

disk A storage device that can be written to and read from. A hard disk is a high capacity storage device contained in a hard disk drive. A floppy disk is a low capacity, removable storage device that must be inserted in a floppy disk drive. In this manual, disk is used synonymously with hard disk, and, sometimes, with floppy disk. Also known as a *physical disk.*

drive group See pack.

drive A housing that contains and powers a storage device. There are, for example, hard disk drives, CD-ROM drives, and tape drives. Sometimes used as a synonym for hard disk. See also *disk.*

fault tolerance The ability of a disk array to maintain data integrity despite the failure of one or more of the disks in the array. See also *availability* and *redundance.*

hot spare A disk that is part of an array but is not part of any *pack* or *system drive.* If a disk in a system drive in a *redundant* disk array fails, the hot spare can take its place with no break in operations. Also known as a *standby disk.*

hot swapping Removing a damaged disk and replacing it with a new disk of the same or greater capacity and the same SCSI ID while the Network Server and all connected external arrays continue to run.

fast and wide See SCSI II.

firmware Code that is stored in Read Only Memory (ROM), and that is not erased when the computer or other intelligent device is turned off.

initialize In this manual, the final preparation of a *system drive* for use.

logical drive See system drive.

mirroring The complete duplication of all data from one disk onto another disk of the same capacity. For normal operations, only one of the disks is used. The mirror disk is reserved as a backup in case the primary disk fails.

offline Referring to a disk in a disk array, the condition of being unavailable for use. A disk is offline if it has been physically removed from the computer or external array, or if it is damaged, or if the administrator has made it offline.

online Referring to a disk in a disk array, the condition of being available for use.

Open Firmware The firmware built in to the Network Server. Open Firmware can support a variety of *operating systems* and also supports some basic functionality when an operating system is not available. The Network Server PCI RAID Disk Array Configuration Utility and Diagnostics Utility run in the Open Firmware environment. See also *firmware.*

operating system software that controls the overall functioning of a computer. Also known as the OS.

pack From one to eight hard disks that have been grouped together by the Network Server PCI RAID Disk Array Configuration Utility.

parity The combined binary value of the original data as *striped* onto a disk array, which value is used to reconstruct data from a failed disk. Parity is the redundancy method used by RAID level 5 disk arrays, and has the advantage of using much less disk capacity than does *mirroring.*

PCI An acronym for peripheral component interface, the PCI standard defines the architecture of the expansion card bus and of the expansion cards themselves that are used in the Network Server.

RAID An acronym for redundant array of independent disks, RAID is the technology used to write data across two or more disks to achieve redundancy by *mirroring* or *parity* and to increase performance by *striping.*

RAID levels The various implementations of the RAID technology to support *mirroring, striping, mirroring* and *striping, or parity* and *striping.*

rebuilding The reconstruction, through the use of redundant data, of the data from a failed disk onto a replacement disk.

redundancy The use of *mirroring* or *parity* to maintain data from each disk in an array across other disks in the array, so that the data from a failed disk can be rebuilt onto a replacement disk. Redundancy is the foundation of *availability* and *fault tolerance.*

SCSI An acronym for small computer standard interface, SCSI is a set of specifications for connecting computers to certain peripheral devices, such as many hard disks, printers, and CD-ROM drives.

SCSI ID A number that is assigned to a SCSI device which the operating system uses to identify that device.

SCSI II A modification of the SCSI specification to permit faster data transfer. SCSI II devices may be *fast* or *wide* or both fast and wide. With a fast SCSI device, data is transferred roughly twice as quickly as with a conventional SCSI device. With a wide SCSI device, roughly twice as much data is transferred at a time. Thus a fast and wide device is roughly four times faster than a conventional device.

standby disk See *hot spare.*

striping A method of writing data across all disks in an array, so as to increase performance.

system drive The logical entity configured by the RAID controller that presents itself to the operating system as a single physical disk. System drives are constructed from packs, and RAID levels and SCSI ID numbers are assigned to them. Also known as *logical drives* or logical disks.

write-back A method of writing data to the *cache* maintained by the controller, and then writing the data from the cache to the disk. Write-back speeds up operations, but data can be lost in a power failure unless the controller has a battery backup, as the Network Server PCI RAID Disk Array Card does.

write-through Writing data directly to disk, without using the *cache.*

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