

IBM ServeRAID



User's Reference, Version 5.10

Note: Before using this information and the product it supports, be sure to read the general information in Appendix B, "Warranty information" on page 183 and Appendix C, "Notices" on page 195.

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Safety

Before installing this product, read the Safety Information book.

مج، يجب قراءة دات السلامة

Antes de instalar este produto, leia o Manual de Informações sobre Segurança.

安裝本产品前请先阅读《安全信息》手册。

Prije instalacije ovog proizvoda pročitajte priručnik sa sigurnosnim uputama.

Před instalací tohoto produktu si přečtěte příručku bezpečnostních instrukcí.

Læs hæftet med sikkerhedsforskrifter, før du installerer dette produkt.

Lue Safety Information -kirjanen, ennen kuin asennat tämän tuotteen.

Avant de procéder à l'installation de ce produit, lisez le manuel Safety Information.

Vor Beginn der Installation die Broschüre mit Sicherheitshinweisen lesen.

Πριν εγκαταστήσετε αυτό το προϊόν, διαβάστε το εγχειρίδιο Safety Information.

לפני שתתקינו מוצר זה, קראו את הוראות הבטיחות.

Przed zainstalowaniem tego produktu należy przeczytać broszurę Informacje Dotyczące Bezpieczeństwa.

Prima di installare questo prodotto, leggere l'opuscolo contenente le informazioni sulla sicurezza.

本製品を導入する前に、安全情報資料を御読みください。

이 제품을 설치하기 전에, 안전 정보 책자를 읽어보십시오.

Пред да го инсталирате овој производ прочитајте ја книгата со безбедносни информации.

Lees voordat u dit product installeert eerst het boekje met veiligheidsvoorschriften.

Les heftet om sikkerhetsinformasjon (Safety Information) før du installerer dette produktet.

Prije instalacije ovog proizvoda pročitajte priručnik sa sigurnosnim uputama.

Antes de instalar este produto, leia o folheto Informações sobre Segurança.

Перед установкой продукта прочтите брошюру по технике безопасности (Safety Information).

Pred inštaláciou tohto produktu si pre ítajte Informa nú brožúrku o bezpe nosti.

Preden namestite ta izdelek, preberite knjižico Varnostne informacije.

Antes de instalar este producto, lea la Información de Seguridad.

Läs säkerhetsinformationen innan du installerar den här produkten.

在安裝本產品之前，也請先閱讀「安全性資訊」小冊子。

Statement 1



Danger

Electrical current from power, telephone, and communication cables is hazardous.

To avoid a shock hazard:

- Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.
- Connect all power cords to a properly wired and grounded electrical outlet.
- Connect to properly wired outlets any equipment that will be attached to this product.
- When possible, use one hand only to connect or disconnect signal cables.
- Never turn on any equipment when there is evidence of fire, water, or structural damage.
- Disconnect the attached power cords, telecommunications systems, networks, and modems before you open the device covers, unless instructed otherwise in the installation and configuration procedures.
- Connect and disconnect cables as described in the following table when installing, moving, or opening covers on this product or attached devices.

To connect:

1. Turn everything OFF.
2. First, attach all cables to devices.
3. Attach signal cables to connectors.
4. Attach power cords to outlet.
5. Turn device ON.

To disconnect:

1. Turn everything OFF.
2. First, remove power cords from outlet.
3. Remove signal cables from connectors.
4. Remove all cables from devices.

Statement 2

CAUTION:



When replacing the lithium battery, use only IBM Part Number 33F8354 or an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:

- Throw or immerse into water.
- Heat to more than 100° C (212° F)
- Repair or disassemble

Dispose of the battery as required by local ordinances or regulations.

Statement 5



CAUTION:

The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.



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Preface

This book provides information for configuring an IBM® ServeRAID™ controller, installing device drivers, and installing and using the ServeRAID utility programs and the IBM ServeRAID Cluster Solution.

Note: The IBM ServeRAID product can be either a controller on an adapter, such as the one in this option package, or a controller on the system board of your server. For consistency in this manual, the ServeRAID product is referred to as a ServeRAID controller, unless it is specifically noted otherwise.

To install device drivers and utility programs for a RAID controller that comes as a standard feature on an IBM server system board, see the *Installation Guide* and CDs provided with your server for instructions.

How this book is organized

Chapter 1, “Product information” on page 3 contains introductory information and specifications for the IBM ServeRAID-4H, ServeRAID-4Mx, ServeRAID-4Lx, and ServeRAID-5i controllers.

Chapter 2, “Installing and cabling a ServeRAID controller” on page 11 explains how to install and cable a ServeRAID-4 and ServeRAID-5i controller.

Chapter 3, “Understanding RAID technology” on page 21 contains general information about RAID technology.

Chapter 4, “Configuring ServeRAID controllers” on page 35 explains the ServeRAID configuration process. You can refer to the information when configuring one or more devices attached to a ServeRAID controller.

Chapter 5, “Installing ServeRAID device drivers” on page 49 contains information about installing and updating the ServeRAID device drivers.

Chapter 6, “Configuring two ServeRAID controllers in a failover environment” on page 51 contains instructions for configuring two ServeRAID controllers in a failover environment. These instructions are for Microsoft® Windows NT® 4.0 and Microsoft Windows® 2000 only.

Chapter 7, “Using the ServeRAID Mini-Configuration program” on page 67, Chapter 8, “Installing and using the IPSSSEND command-line program” on page 71, and Chapter 9, “Using the IPSMON command-line program (NetWare only)” on page 91 contain instructions for installing, starting, and using the Mini-Configuration, IPSSSEND, and IPSMON programs. You can use these operating-system-specific programs to maintain and monitor your ServeRAID subsystem.

Chapter 10, “Installing and starting the ServeRAID Manager program” on page 93 contains instructions for installing and starting the ServeRAID Manager program. You can use this program to maintain and monitor your ServeRAID subsystem.

Chapter 11, “Introduction to the IBM ServeRAID Cluster Solution” on page 103 and Chapter 12, “Preparing to install or change a cluster solution” on page 107 provide general information about the IBM ServeRAID Cluster Solution, including terms, definitions, and considerations.

Chapter 13, “Configuring ServeRAID controllers for clustering” on page 111 explains the procedure for configuring ServeRAID controllers for clustering when using Microsoft Cluster Server (MSCS).

Chapter 14, “Installing the Microsoft Cluster Server software” on page 119 provides the procedure for installing Microsoft Cluster Server on Windows 2000 and Windows NT 4.0.

Chapter 15, “Monitoring and updating an IBM ServeRAID Cluster Solution” on page 135 contains information for monitoring and updating an IBM ServeRAID Cluster Solution.

Chapter 16, “Obtaining ServeRAID updates” on page 141 provides information for obtaining IBM ServeRAID and IBM ServeRAID Cluster Solution updates from the World Wide Web.

Chapter 17, “Upgrading a ServeRAID controller” on page 143 contains instructions for upgrading your ServeRAID controller.

Chapter 18, “Solving ServeRAID problems” on page 145 describes the ServeRAID POST error codes and startup messages. This chapter also includes some basic information about rebuilding a defunct drive and troubleshooting failover and cluster problems.

Chapter 19, “Getting help and technical assistance” on page 175 provides information about accessing the IBM World Wide Web sites to obtain future code and information updates for the ServeRAID controller.

Appendix A, “Creating ServeRAID diskettes” on page 179 contains instructions for creating the *IBM ServeRAID Support* diskettes, which contain device drivers and the IPSEND utility program.

Appendix B, “Warranty information” on page 183 contains warranty information.

Appendix C, “Notices” on page 195 contains product notices and trademarks.

Notices that are used in this book

This book contains the following notices designed to highlight key information:

- **Notes:** These notices provide important tips, guidance, or advice.
- **Important:** These notices provide information or advice that might help you avoid inconvenient or difficult situations.
- **Attention:** These notices indicate possible damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage could occur.
- **Caution:** These statements indicate situations that can be potentially hazardous to you. A caution statement is placed just before the description of a potentially hazardous procedure step or situation.
- **Danger:** These statements indicate situations that can be potentially lethal or extremely hazardous to you. A danger statement is placed just before the description of a potentially lethal or extremely hazardous procedure step or situation.

IBM ServeRAID Support CD

The *IBM ServeRAID Support CD* contains the following:

- ServeRAID ROM Update Wizard
- Device drivers
- ServeRAID Manager program
- IPSSSEND command-line program
- Diskette images
- ServeRAID files needed to install Microsoft Cluster Server (MSCS)
- ServeRAID publications

ServeRAID ROM Update Wizard

The IBM ServeRAID ROM (read-only memory) Update Wizard is a program designed to automatically identify and scan each ServeRAID controller installed in your server. If the BIOS and firmware code need updating, the wizard will give you the opportunity to do so.

Device drivers

The device drivers are located in the following directory on the *IBM ServeRAID Support CD*:

e:/operatingsystem/DRIVER

where *e* is the CD-ROM drive and *operatingsystem* is the specific operating system used in the ServeRAID installation.

The device drivers are also located on the operating-system-specific *IBM ServeRAID Support* diskettes.

ServeRAID Manager program

Use this program to configure arrays and logical drives using ServeRAID controllers. ServeRAID Manager operates in two ways: in startable-CD mode and as an installed program. In startable-CD mode, you can configure your ServeRAID adapter *before* you install an operating system.

This program is available in the following directory:

e:/operatingsystem/MANAGER

where *e* is the CD-ROM drive and *operatingsystem* is the specific operating system used in the ServeRAID installation.

IPSSSEND command-line program

Use this program to configure and manage your ServeRAID controllers. This program is available on both the *IBM ServeRAID Support CD* and the operating-system-specific *IBM ServeRAID Support* diskettes.

Diskette images

Use these images to create the ServeRAID diskettes. These diskettes include the following:

- *IBM ServeRAID BIOS and Firmware Update (1 of 3) diskette*
- *IBM ServeRAID BIOS and Firmware Update (2 of 3) diskette*
- *IBM ServeRAID BIOS and Firmware Update (3 of 3) diskette*
- *IBM ServeRAID Failover Support for Windows NT 4.0 and Windows 2000 diskette*
- *IBM ServeRAID Cluster Solution for Windows NT 4.0 and Windows 2000 diskette*
- *IBM ServeRAID Support for Windows 2000 Server diskette*
- *IBM ServeRAID Support for Windows (Professional Editions) diskette*
- *IBM ServeRAID Support for Windows NT 4.0 diskette*
- *IBM ServeRAID Support for IBM OS/2 diskette*
- *IBM ServeRAID Support for Novell NetWare diskette*
- *IBM ServeRAID Support for Caldera UnixWare and Open UNIX diskette*
- *IBM ServeRAID Support for SCO OpenServer diskette*
- *IBM ServeRAID Support for Red Hat Linux (1 of 2) diskette*
- *IBM ServeRAID Support for Red Hat Linux (2 of 2) diskette*
- *IBM ServeRAID Support for Caldera OpenLinux (1 of 2) diskette*
- *IBM ServeRAID Support for Caldera OpenLinux (2 of 2) diskette*
- *IBM ServeRAID Support for SuSE Linux diskette*
- *IBM ServeRAID Support for Turbolinux diskette*
- *IBM ServeRAID Support for DOS diskette*

These files are available in the *e:/DISKETTE* directory, where *e* is the CD-ROM drive.

For instructions on creating the diskettes, see Appendix A, “Creating ServeRAID diskettes” on page 179.

ServeRAID files needed to install Microsoft Cluster Server (MSCS)

Note: The IBM ServeRAID Cluster Solution requires either Windows 2000 or Windows NT 4.0.

These files are available in the following directory:

e:/operatingsystem/CLUSTER

where *e* is the CD-ROM drive and *operatingsystem* is the specific operating system used in the ServeRAID installation.

ServeRAID publications

The following books are available in Portable Document Format (PDF) on the *IBM ServeRAID Support* CD in the */BOOKS* directory:

- *IBM ServeRAID User's Reference, Version 5.10 (SRAID51.PDF)*
- *IBM ServeRAID Device Driver Installation Instructions (DEVDRV51.PDF)*

The following booklets are extracted from the *IBM ServeRAID User's Reference, Version 5.10* and are available on the *IBM ServeRAID Support CD* in the `/BOOKS` directory:

- *IBM ServeRAID-4 Ultra160 and ServeRAID-5i Ultra320 SCSI Controllers Installation Guide* (INSTAL51.PDF)
- *Configuring IBM ServeRAID Controllers for Failover* (FAILOV51.PDF)
- *Installing the IBM ServeRAID Cluster Solution* (CLUSTE51.PDF)
- *Understanding IBM ServeRAID Technology* (TECHNO51.PDF)

Note: Use Adobe Acrobat Reader to view these files. The *IBM ServeRAID Support CD* contains the Acrobat Readers for Microsoft Windows, IBM OS/2®, and Linux® in the `/BOOKS/READERS` directory.

If you are installing the IBM ServeRAID Cluster Solution, you might need to refer to the *IBM Shared Disk Clustering Hardware Reference*. This book provides general information about planning and configuring a shared-disk cluster using IBM server products. It contains illustrations, descriptions, and parts listings for various high-availability, shared-disk cluster examples.

Note: You can obtain this publication from the IBM Support Web site. See “Downloadable files from the World Wide Web” on page 141 for additional information.

In addition, the following IBM Redbooks™ might be of interest:

- *Implementing Netfinity Disk Subsystems: ServeRAID SCSI, Fibre Channel, and SSA*
- *Tuning Netfinity Servers for Performance: Getting the most out of Windows 2000 and Windows NT 4.0*
- *Netfinity Director: Integration and Tools*
- *Netfinity Clustering Planning Guide*

You can download these books from the IBM Web site at <http://www.ibm.com/redbooks/>.

Supported operating systems

The following operating systems are supported with ServeRAID-4 and ServeRAID-5i controllers:

- Microsoft XP Professional (ServeRAID-4Lx controller only)
- Microsoft Windows 2000 Advanced Server, Datacenter, and Server
- Microsoft Windows 2000 Professional (ServeRAID-4Lx controller only)
- Microsoft Windows NT 4.0 Enterprise Edition and Server
- Novell NetWare (versions 5.x and 6.0)
- IBM OS/2 WARP® Server for e-business
- Red Hat Linux (versions 6.2, 7.0, 7.1, 7.2, and 7.3)
- SuSE Linux (versions 7.1, 7.2, 7.3, and 8.0)
- Caldera OpenLinux (versions 3.1 and 3.1.1)
- Turbolinux (versions 6.5 and 7.0)
- SCO OpenServer 5.0.6a
- Caldera UnixWare 7.1.1
- Caldera Open UNIX 8.0

Part 1. Installation and configuration

Chapter 1. Product information

This book provides the information needed to install and configure the following:

- IBM ServeRAID-4H Ultra160 SCSI controller
- IBM ServeRAID-4Mx Ultra160 SCSI controller
- IBM ServeRAID-4Lx Ultra160 SCSI controller
- IBM ServeRAID-5i Ultra320 SCSI controller

Hereafter, these controllers are referred to as ServeRAID controllers. These high-performance, redundant array of independent disk (RAID) controllers are ideally suited for data-storage environments that require superior performance, flexibility, and reliable data storage. (See “Controller features” for more information.)

You also can use the IBM ServeRAID Manager program with an IBM xSeries™ server that contains an integrated SCSI controller with RAID capabilities. Hereafter, these controllers are referred to as integrated RAID controllers.

Option package contents

In addition to this book, the ServeRAID option package contains:

- *IBM ServeRAID Support CD*
See “IBM ServeRAID Support CD” on page xiii for more detailed information.
- One of the following:
 - IBM ServeRAID-4H Ultra160 SCSI controller
 - IBM ServeRAID-4Mx Ultra160 SCSI controller
 - IBM ServeRAID-4Lx Ultra160 SCSI controller
 - IBM ServeRAID-5i Ultra320 SCSI controller

Attention: Do not open the static-protective package containing the controller until you are instructed to do so.

Contact your place of purchase if any items are missing or damaged.

Controller features

The standard features of the ServeRAID controllers are as follows.

Feature	ServeRAID-5i	ServeRAID-4H	ServeRAID-4Mx	ServeRAID-4Lx
Arrays (max.)	8	8	8	8
Battery-backup cache	Yes	Yes	Yes	No
Cache memory	128 MB	128 MB	64 MB	32 MB
Hard disk drives (max.)	30	60	30	15
Logical drives (max.)	8	8	8	8
Microprocessor	100 MHz	266 MHz	100 MHz	100 MHz
SCSI channels	0	4	2	1
SCSI transfer speed (max.)	320 MB per sec.	160 MB per sec.	160 MB per sec.	160 MB per sec.

Feature	ServeRAID-5i	ServeRAID-4H	ServeRAID-4Mx	ServeRAID-4Lx
Supported RAID levels	0, 1, 5, Enhanced-1 (1E), 00, 10, 1E0, 50	0, 1, 5, Enhanced-1 (1E), and Enhanced-5 (5E), 00, 10, 1E0, 50	0, 1, 5, Enhanced-1 (1E), and Enhanced-5 (5E), 00, 10, 1E0, 50	0, 1, 5, Enhanced-1 (1E), and Enhanced-5 (5E), 00, 10, 1E0, 50
System PCI data bus	64 bit at 66 MHz	64 bit at 33 MHz	64 bit at 33 to 66 MHz	64 bit at 33 to 66 MHz

The ServeRAID controllers support the following features of ServeRAID software and utility programs.

ServeRAID features	ServeRAID-5i	ServeRAID-4H	ServeRAID-4Mx	ServeRAID-4Lx
ServeRAID ROM Update Wizard	Yes	Yes	Yes	Yes
ServeRAID Manager	Yes	Yes	Yes	Yes
ServeRAID Mini-Configuration program	Yes	Yes	Yes	Yes
IPSEND	Yes	Yes	Yes	Yes
IPSEND FlashCopy® function (Windows XP Professional, Windows 2000, and Windows NT only)	No	Yes	Yes	Yes
IPSMON (NetWare only)	Yes	Yes	Yes	Yes
Clustering (Windows NT and Windows 2000 only)	No	Yes	Yes	Yes
Failover (Windows NT and Windows 2000 only)	No	Yes	Yes	Yes

Connector locations

This section provides illustrations of the SCSI channel connectors and cable connectors for the ServeRAID-4H, ServeRAID-4Mx, ServeRAID-4Lx, and ServeRAID-5i controllers.

The light-emitting diodes (LEDs) on the controllers indicate activity on the SCSI channels and provide diagnostic information for trained service technicians.

ServeRAID-4H controller

The ServeRAID-4H controller has four independent SCSI channel connectors: Channel 1, Channel 2, Channel 3, and Channel 4. Each of these SCSI channels supports up to 15 physical devices.

Note: In the event of a power outage or failure, the battery-backup cache protects the data stored in the ServeRAID cache memory when using the write-back setting of the write-cache mode.

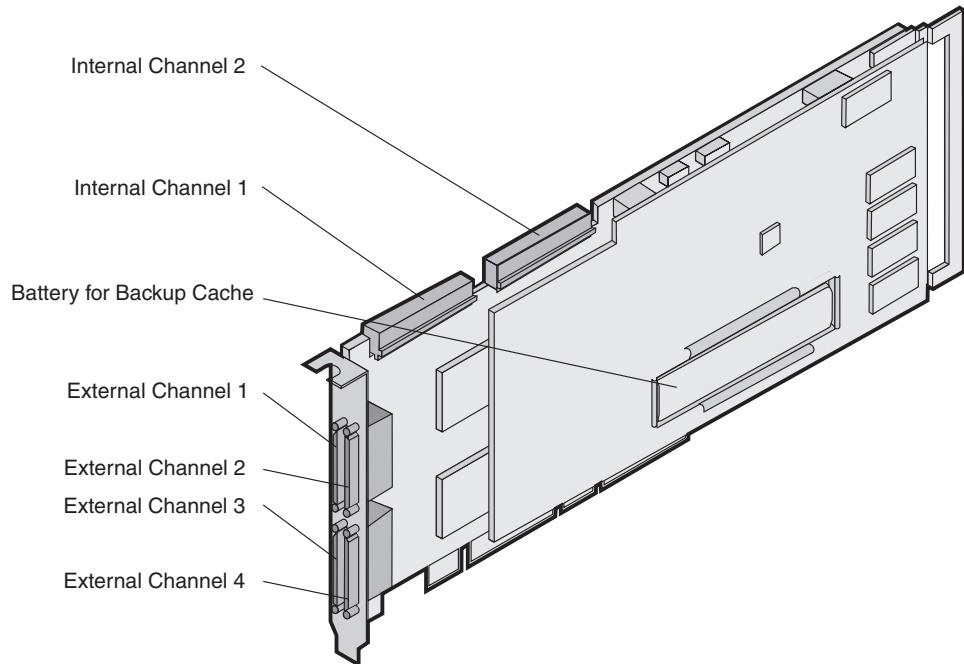


Figure 1. ServeRAID-4H controller

You can attach internal SCSI devices to the internal Channel 1 and Channel 2 connectors. You can attach external SCSI devices to the external Channel 1, Channel 2, Channel 3, and Channel 4 connectors. You cannot attach internal *and* external SCSI devices to the same channel. For example, you cannot attach devices to both external Channel 1 and internal Channel 1. The ServeRAID-4 controllers do not support configurations that use both the internal and external connectors on the same channel *concurrently*.

Note: The ServeRAID-4H controller uses the module (P/N 38L3386) containing a lithium battery.

Statement 2
CAUTION:



When replacing the lithium battery, use only IBM Part Number 33F8354 or an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:

- **Throw or immerse into water.**
- **Heat to more than 100° C (212° F)**
- **Repair or disassemble**

Dispose of the battery as required by local ordinances or regulations.

ServeRAID-4Mx controller

The ServeRAID-4Mx controller has two independent SCSI channel connectors: Channel 1 and Channel 2. Each of these SCSI channels supports up to 15 physical devices.

Note: In the event of a power outage or failure, the battery-backup cache protects the data stored in the ServeRAID cache memory when using the write-back setting of the write-cache mode.

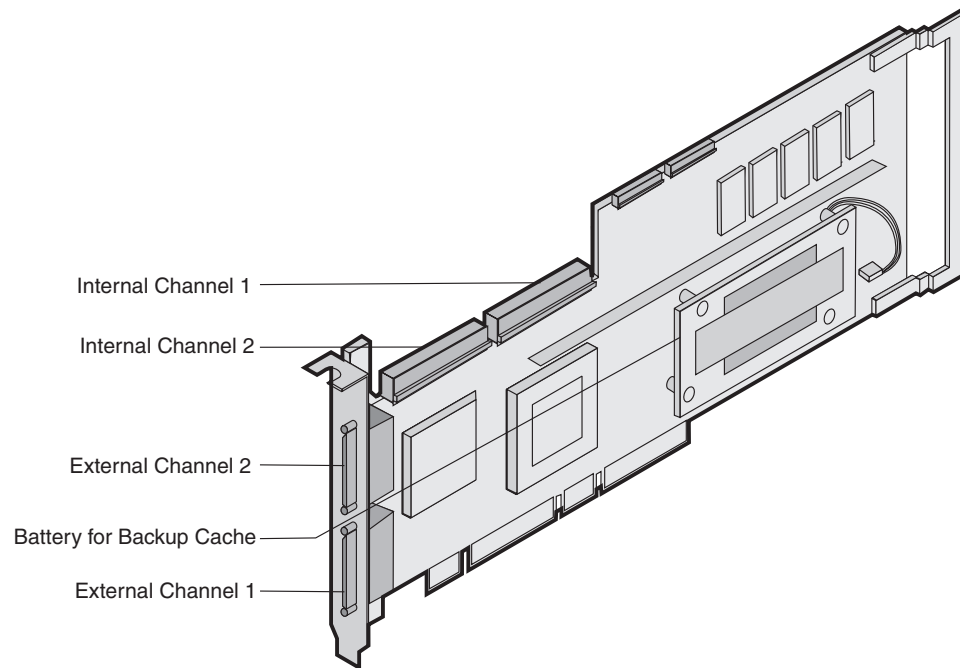


Figure 2. ServeRAID-4Mx controller

You can attach internal SCSI devices to the internal Channel 1 and Channel 2 connectors. You can attach external SCSI devices to the external Channel 1 and Channel 2 connectors. You cannot attach internal *and* external SCSI devices to the same channel. For example, you cannot attach devices to both external Channel 1 and internal Channel 1. The ServeRAID-4 controllers do not support configurations that use both the internal and external connectors on the same channel *concurrently*.

Note: The ServeRAID-4Mx controller uses the module (P/N 38L3386) containing a lithium battery.

Statement 2

CAUTION:



When replacing the lithium battery, use only IBM Part Number 33F8354 or an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:

- Throw or immerse into water.
- Heat to more than 100° C (212° F)
- Repair or disassemble

Dispose of the battery as required by local ordinances or regulations.

ServeRAID-4Lx controller

The ServeRAID-4Lx controller has one independent SCSI channel connector, Channel 1. This SCSI channel supports up to 15 physical devices.

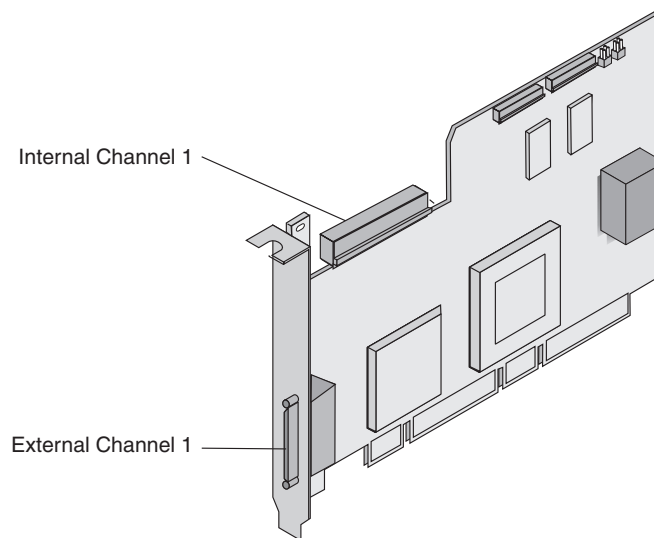


Figure 3. ServeRAID-4Lx controller

You can attach internal SCSI devices to the internal Channel 1 connector. You can attach external SCSI devices to the external Channel 1 connector. You cannot attach internal *and* external SCSI devices to the same channel. For example, you cannot attach devices to both external Channel 1 and internal Channel 1. The ServeRAID-4 controllers do not support configurations that use both the internal and external connectors on the same channel *concurrently*.

Note: The ServeRAID-4Lx controller uses the module (P/N 38L3386) containing a lithium battery.

Statement 2

CAUTION:



When replacing the lithium battery, use only IBM Part Number 33F8354 or an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:

- Throw or immerse into water.
- Heat to more than 100° C (212° F)
- Repair or disassemble

Dispose of the battery as required by local ordinances or regulations.

ServeRAID-5i controller

The ServeRAID-5i controller has no independent SCSI channel connectors. It must be used with an IBM xSeries server that contains an integrated RAID controller. It comes with both a 2-U and 3-U I/O bracket; the 3-U bracket is mounted on the controller.

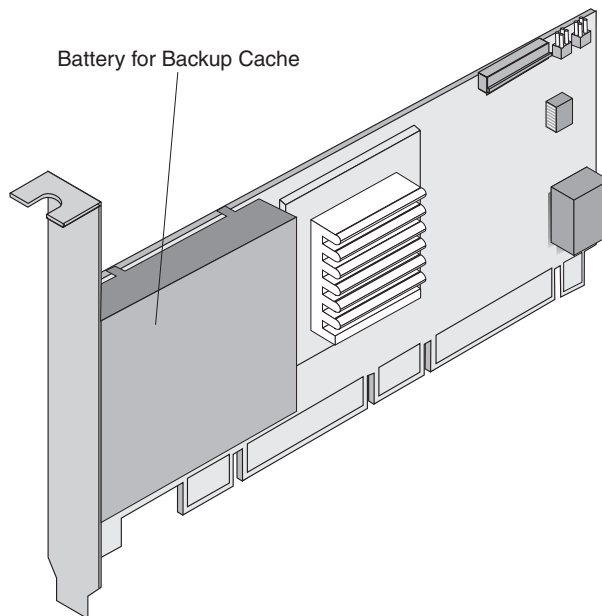


Figure 4. ServeRAID-5i controller

Note: The ServeRAID-5i controller uses the module (P/N 38L3386) containing a lithium battery.

Statement 2

CAUTION:



When replacing the lithium battery, use only IBM Part Number 33F8354 or an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:

- Throw or immerse into water.
- Heat to more than 100° C (212° F)
- Repair or disassemble

Dispose of the battery as required by local ordinances or regulations.

Chapter 2. Installing and cabling a ServeRAID controller

This chapter provides installation and cabling instructions for the IBM ServeRAID controllers.

You can install a maximum of 12 ServeRAID controllers in a server.

Using a ServeRAID controller in a server with Active PCI features

Note: The ServeRAID-5i controller does not support Active™ PCI features.

Some IBM servers support Active PCI (also called hot-plug PCI) features. The ServeRAID-3 and ServeRAID-4 controllers support Active PCI features on Windows NT 4.0, Windows 2000, and Novell NetWare. The following table summarizes which operating systems support specific Active PCI functions:

Feature	Windows NT 4.0	Windows 2000	NetWare 5.x	NetWare 6.0
Hot add	Yes	Yes	Yes	Yes
Hot remove	No	Yes	Yes	Yes
Hot replace	Yes	No	No	No

You can use the Active PCI features to install, remove, or replace PCI controllers without turning off the server.

- Use the hot-add feature to add a controller to a running server, thus expanding its capacity.
- Use the hot-remove feature to remove a controller from a running server.
- Use the hot-replace feature to replace a controller with an identical controller.

Note: When you use the hot-replace feature, some parameters (such as rebuild rate) are not restored. If you have previously saved the controller configuration, refer to it for information.

Attention: Do *not* attempt a hot-replace operation on Windows 2000 or NetWare by hot-removing a failed controller and then hot-adding a new controller. Loss of data can occur. If a controller fails on these operating systems, you *must* shut down the server to replace the controller.

Using Windows NT 4.0 with Active PCI features

To use Active PCI with Windows NT 4.0 and a ServeRAID controller, you must install the following software components in this order:

1. DMI Service provider. A free version is included on the *IBM ServeRAID Support CD* in the following directory:
e:\WINNT\DMISP\setup.exe
where e is the CD-ROM drive.

Note: This version is sufficient for most users' needs, but a Y2K compliant version is available at <http://www.enablers.com/>.

2. IBM Hot Plug for Windows NT 4.0 Package, version 4.2 or later. This package is available from the IBM Support Web site. See “Downloadable files from the World Wide Web” on page 141 for additional information.

Note: Be sure to read the instructions and restrictions for this software program.

3. ServeRAID Active PCI DMI component. This is an optional component that you can install during the ServeRAID Manager installation.

To perform a hot-replace operation, start the IBM ServeRAID Hot Replace Wizard. You can start this program from within either the IBM Hot Plug for Windows NT 4.0 program or the ServeRAID Manager program. You can use the ServeRAID Manager program to start the wizard either on the server with the failed controller, or across the network from a remote installation of the ServeRAID Manager.

Note: It is useful to start the IBM ServeRAID Hot Replace Wizard from a remote installation when the server with the failed controller does not have a monitor.

Using Windows 2000 with Active PCI features

To use Active PCI with Windows 2000, you must install the IBM Active PCI Software for Windows 2000. This software is available from the IBM Support Web site. See “Downloadable files from the World Wide Web” on page 141 for additional information.

Note: Be sure to read the instructions and restrictions for this software program.

Using NetWare with Active PCI features

To use Active PCI with NetWare, you must install the IBM PCI Hot-Plug Controller Driver for NetWare. This software is available from the IBM Support Web site. See “Downloadable files from the World Wide Web” on page 141 for additional information.

Note: Be sure to read the instructions and restrictions for this software program.

Installing the ServeRAID-4 controller

During the installation, you might need a small, flat-blade screwdriver and the documentation that comes with your server.

Complete the following steps to install the ServeRAID-4 controller:

1. Review “Safety” on page iii and the Safety Information book provided with your server.

Note: Some IBM servers support Active PCI features, which enable you to install or remove PCI controllers without turning off the server. If your server model provides Active PCI support and you are using Windows 2000, Windows NT 4.0, NetWare 5.0, or NetWare 6.0, you do not need to turn off your server to install this controller. This operation is referred to as a hot-add operation. Before performing this operation, complete the following tasks:

- Review the information provided with your server to determine whether your model supports these features.

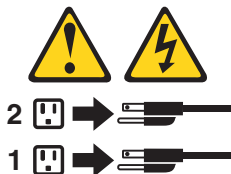
- Review the documentation provided with your operating system for information concerning using these features.
 - See “Using a ServeRAID controller in a server with Active PCI features” on page 11.
2. If your server model does *not* support Active PCI, turn off the server and disconnect all power cords and cables from the server.

Statement 5



CAUTION:

The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.



3. Remove the server cover and locate an empty PCI expansion slot for the controller. Choose a slot that is farthest from other installed components, such as the microprocessor. If necessary, see your server documentation for more detailed information about the expansion slots.

Note: Some server models require that you install the ServeRAID controller in a specific PCI slot. See the documentation that came with your server for more information.

4. Remove the expansion-slot cover, if applicable.
5. Touch the static-protective package containing the controller to an unpainted metal expansion-slot cover on the server. This discharges any static electricity from the package and your body.
6. Holding the controller by the edges, remove it from the static-protective package. Do not touch any exposed components on the controller.
7. Insert the controller into the PCI expansion slot. Press the controller firmly into the slot so that it is fully seated.

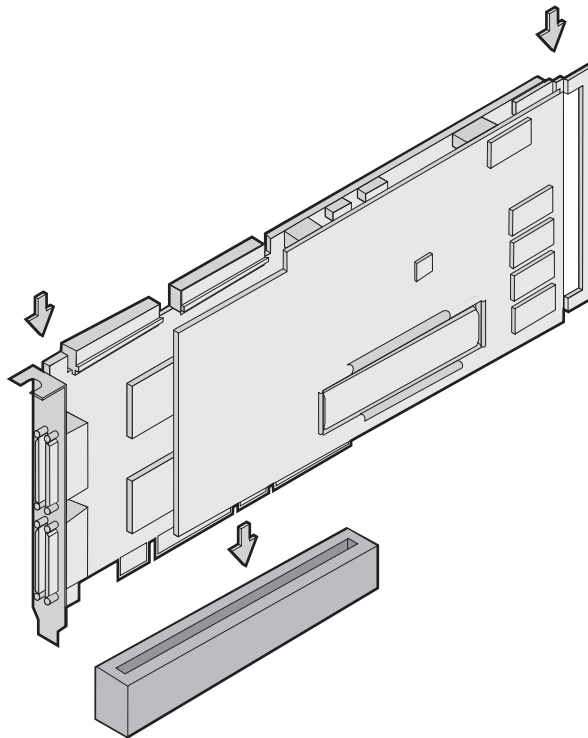


Figure 5. Inserting a ServeRAID-4H controller into the PCI expansion slot

8. Secure the controller by either tightening the expansion-slot screw on the top of the controller or closing the latch, depending on your server.
9. Connect the SCSI cables to the controller. If you intend to attach external devices only, go to step 13 on page 15. Otherwise, go to step 10.
10. Connect one end of a 68-pin standard cable (separately purchased or already in your server) to the internal channel connector on the ServeRAID controller.

Note: See “Connector locations” on page 4 for the channel connector locations.

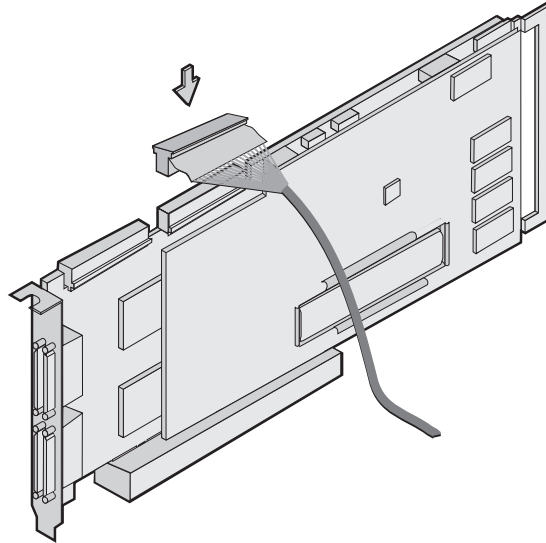


Figure 6. Connecting a ServeRAID-4H controller internal channel connector

11. Connect the other end of the SCSI cable to the SCSI backplane or to a SCSI device in the server. (See your server documentation or the system label inside the server cover for the location of the SCSI connector on the backplane.)
12. If you have physical drives to install, install them now. See your server documentation for drive installation instructions.
13. Install the server cover.
14. If you disconnected the cables and power cords in step 2 on page 13, reconnect the cables and cords. See your server documentation if you need detailed instructions.
15. If you want to attach an external SCSI device to the ServeRAID controller, go to “Connecting external devices to a ServeRAID-4 controller”. Otherwise, go to Chapter 3, “Understanding RAID technology” on page 21.

Connecting external devices to a ServeRAID-4 controller

Note: You cannot attach internal *and* external SCSI devices to the same channel. For example, you cannot attach devices to both external Channel 1 and internal Channel 1. The ServeRAID-4 controllers do not support configurations that use both the internal and external connectors on the same channel *concurrently*.

Complete the following steps to attach SCSI devices to an external channel connector on the ServeRAID-4 controller:

1. Connect one end of a 68-pin very-high-density connector interface (VHDCI) SCSI cable to an external channel connector on the ServeRAID controller.

Note: See “Connector locations” on page 4 for the channel connector locations.

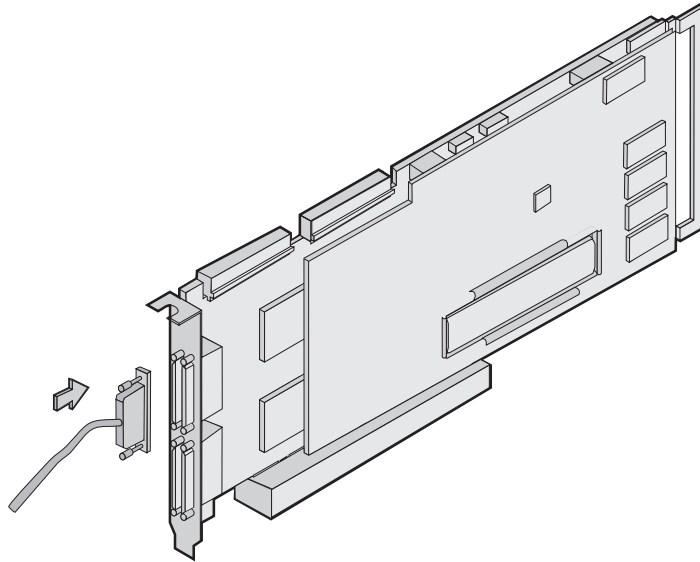


Figure 7. Connecting a ServeRAID-4H controller external channel connector

2. Connect the other end of the SCSI cable to the external SCSI device.
3. Go to “Updating BIOS and firmware code” on page 35.

Installing the ServeRAID-5i controller

Attention: If you plan to install a ServeRAID-5i controller into a server that contains data, back up the data first. When the ServeRAID-5i controller is installed, you will lose access to any data or applications on physical drives connected to the integrated RAID controller.

Preparing for installation

Before you begin the installation procedure, see the documentation that comes with your server. You need to determine the following:

- The PCI expansion slot into which you will install the controller
- Whether you need to install the low-profile 2-U bracket

Complete the following steps to install the 2-U bracket. You will need a small, flat-blade screwdriver.

1. Holding the controller by the edges, remove it from the static-protective package. Do not touch any exposed components on the controller.
2. Set the controller battery-side down on a nonconductive, static-protected surface. Do not place the controller on your server cover or on a metal table.
3. Using a small, flat-blade screwdriver, remove the screw from the battery pack.

4. To remove the battery, gently press the tab up and lift the battery away from the controller.

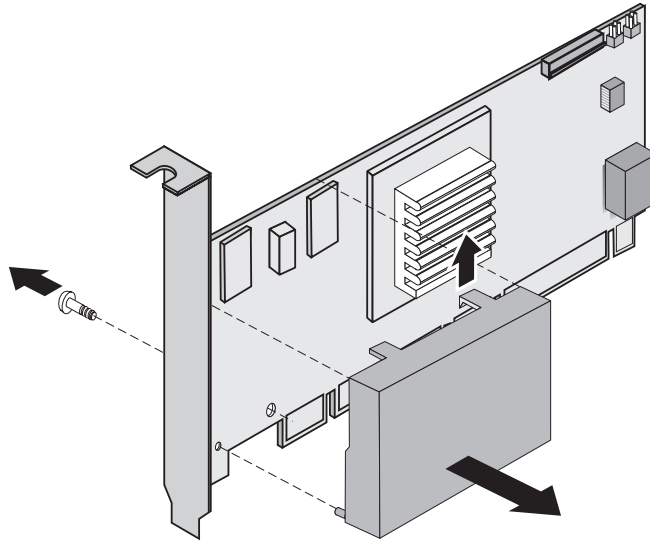


Figure 8. Removing the battery from a ServeRAID-5i controller

5. Remove the two bracket screws. Set them aside.
6. Remove the 3-U bracket.
7. Align the two screw holes in the 2-U bracket with the two screw holes on the controller. Using the two screws you removed in step 5, secure the bracket to the controller.
8. Gently snap the battery back into place.
9. Using the screw you removed in step 3 on page 16, secure the battery to the controller.
10. Return the controller to the static-protective package.

Installing the ServeRAID-5i controller

During the installation, you might need a small, flat-blade screwdriver and the documentation that comes with your server.

Complete the following steps to install the ServeRAID-5i controller:

1. Review “Safety” on page iii and the Safety Information book provided with your server.
2. Turn off the server and disconnect all power cords and cables from the server.

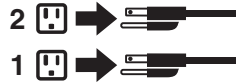
Statement 5



CAUTION:

The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.

Statement 5



3. Remove the server cover and locate the PCI expansion slot.

Notes:

- a. The ServeRAID-5i controller *must* be installed in an extended PCI expansion slot. If you have not already done so, see the documentation that comes with your server to determine the correct PCI expansion slot for the ServeRAID-5i controller.
 - b. If another controller is already installed in the extended PCI expansion slot designed for the ServeRAID-5i controller, you must remove the controller before installing the ServeRAID-5i controller.
4. Remove the expansion-slot cover, if applicable.
 5. Touch the static-protective package containing the controller to an unpainted metal expansion-slot cover on the server. This discharges any static electricity from the package and your body.
 6. Holding the controller by the edges, remove it from the static-protective package. Do not touch any exposed components on the controller.
 7. Insert the controller into the PCI expansion slot. Press the controller firmly into the slot so that it is fully seated.

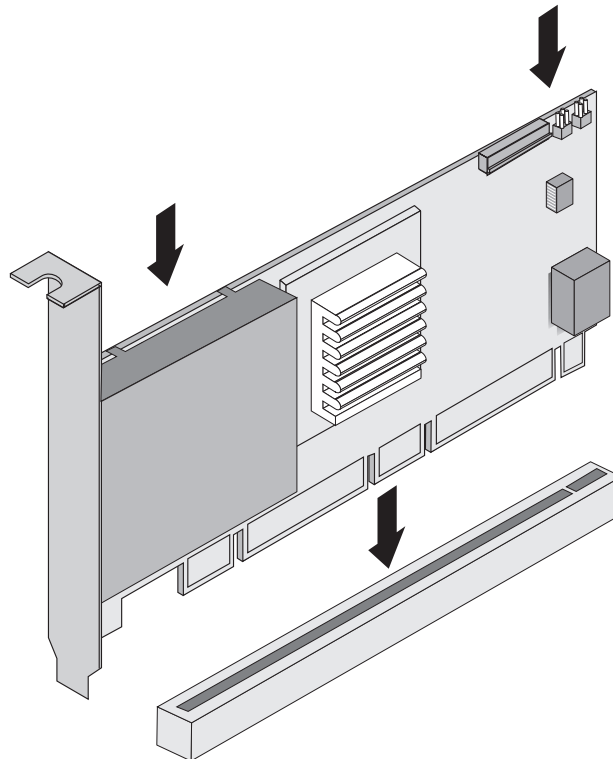


Figure 9. Inserting a ServeRAID-5i controller into the PCI expansion slot

8. Secure the controller by either tightening the expansion-slot screw on the top of the controller or closing the latch, depending on your server.
9. If you have physical drives to install, install them now. See your server documentation for drive installation instructions.
10. Install the server cover.
11. Reconnect the cables and cords. See your server documentation if you need detailed instructions.

Chapter 3. Understanding RAID technology

Redundant array of independent disks (RAID) is the technology of grouping several *physical* drives in a computer into an *array* that you can define as one or more logical drives. Each *logical* drive appears to the operating system as a single drive. This grouping technique greatly enhances logical-drive capacity and performance beyond the physical limitations of a single physical drive.

When you group multiple physical drives into a logical drive, the ServeRAID controller can transfer data in parallel from the multiple drives in the array. This parallel transfer yields data-transfer rates that are many times higher than with nonarrayed drives. This increased speed makes the system better able to meet the *throughput* (the amount of data processed in a given amount of time) or productivity needs of the multiple-user network environment.

The ability to respond to multiple data requests provides not only an increase in throughput, but also a decrease in response time. The combination of parallel transfers and simultaneous responses to multiple requests enables disk arrays to provide a high level of performance in network environments.

Note: If you already understand these concepts, go to Chapter 4, “Configuring ServeRAID controllers” on page 35.

Stripe-unit size

With RAID technology, data is *striped* across an array of physical drives. This data-distribution scheme complements the way the operating system requests data.

The granularity at which data is stored on one drive of the array before subsequent data is stored on the next drive of the array is called the *stripe-unit size*.

You can set the stripe-unit size to 8 KB, 16 KB, 32 KB, or 64 KB. You can maximize the performance of your ServeRAID controller by setting the stripe-unit size to a value that is close to the size of the system I/O requests. For example, performance in transaction-based environments, which typically involve large blocks of data, might be optimal when the stripe-unit size is set to 32 KB or 64 KB. However, performance in file and print environments, which typically involve multiple small blocks of data, might be optimal when the stripe-unit size is set to 8 KB or 16 KB.

The collection of stripe units, from the first drive of the array to the last drive of the array, is called a *stripe*.

Selecting a RAID level and tuning performance

Disk arrays are used to improve performance and reliability. The amount of improvement depends on the application programs that you run on the server and the RAID levels that you assign to the logical drives.

Each RAID level provides different levels of fault-tolerance (data redundancy), utilization of physical drive capacity, and read and write performance. In addition, the RAID levels differ in regard to the minimum and maximum number of physical drives that are supported.

When selecting a RAID level for your system, consider the following factors.

RAID level	Data redundancy	Physical drive capacity utilization	Read performance	Write performance	Built-in spare drive	Min. number of drives	Max. number of drives
RAID level-0	No	100%	Superior	Superior	No	1	16
RAID level-1	Yes	50%	Very high	Very high	No	2	2
RAID level-1E	Yes	50%	Very high	Very high	No	3	16
RAID level-5	Yes	67% to 94%	Superior	High	No	3	16
RAID level-5E	Yes	50% to 88%	Superior	High	Yes	4	16
RAID level-00	No	100%	Superior	Superior	No	2	60
RAID level-10	Yes	50%	Very high	Very high	No	4	60
RAID level-1E0	Yes	50%	Very high	Very high	No	6	60
RAID level-50	Yes	67% to 94%	Superior	High	No	6	60

Physical drive utilization, read performance, and write performance depend on the number of drives in the array. Generally, the more drives in the array, the better the performance.

Supported RAID levels

The ServeRAID controllers support RAID level-0, level-1, level-1E, level-5, level-5E, level-00, level-10, level-1E0, and level-50.

The integrated RAID controllers support RAID level-1 only. The ServeRAID-5i controller does not support RAID level-5E.

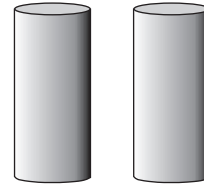
Understanding RAID level-0

RAID level-0 stripes the data across all the drives in the array. This offers substantial speed enhancement but provides no data redundancy. RAID level-0 provides the largest storage capacity of the RAID levels that are offered, because no room is taken for redundant data or data-parity storage.

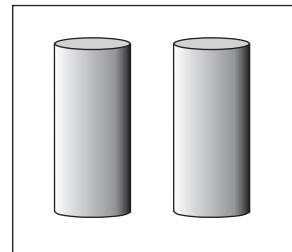
RAID level-0 requires a minimum of one drive and, depending upon the level of firmware and the stripe-unit size, supports a maximum of 8 or 16 drives.

The following illustration shows an example of a RAID level-0 logical drive.

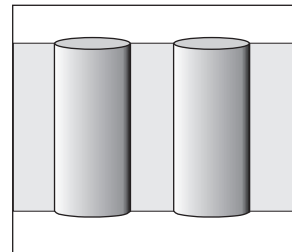
Start with two physical drives.



Create an array using the two physical drives.

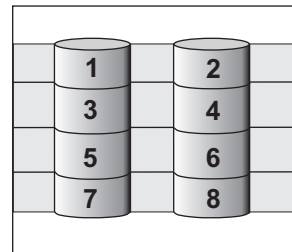


Then create a logical drive within that array.



The data is striped across the drives, creating blocks.

Notice that the data is striped across all the drives in the array, but no redundant data is stored.



A physical drive failure within the array results in loss of data in the logical drive assigned RAID level-0, but only in that logical drive. If you have logical drives assigned RAID level-1, level-1E, level-5, or level-5E in the same array, they will not lose data.

Note: If you have an array that contains only one physical drive, you can assign only RAID level-0 to the logical drive in that array.

When you replace a failed drive, the ServeRAID controller can rebuild all the RAID level-1, level-1E, level-5, and level-5E logical drives automatically onto the replacement physical drive. However, any data stored in a failed RAID level-0 logical drive is lost.

Although the risk of data loss is present, you might want to assign RAID level-0 to a logical drive to take advantage of the speed this RAID level offers. You can use this logical drive to store data that you back up each day and can re-create easily. You also might want to use a RAID level-0 logical drive when you require maximum capacity.

RAID level-0 offers the following advantages and disadvantages.

Advantages	Disadvantages
<ul style="list-style-type: none"> • Substantial speed enhancement • Maximum utilization of physical drive storage capacity, because no room is taken for redundant data or data-parity storage 	<p>No data redundancy, resulting in data loss in the event that a physical drive fails</p>

Understanding RAID level-1

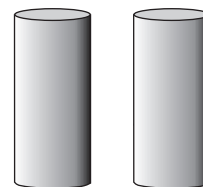
RAID level-1 uses data mirroring. Two physical drives are combined into an array, and data is striped across the array. The first half of a stripe is the original data; the second half of a stripe is a *mirror* (that is, a copy) of the data, but it is written to the other drive in the RAID level-1 array.

RAID level-1 provides data redundancy and high levels of performance, but the storage capacity is diminished. Because the data is mirrored, the capacity of the logical drive when assigned RAID level-1 is 50% of the array capacity.

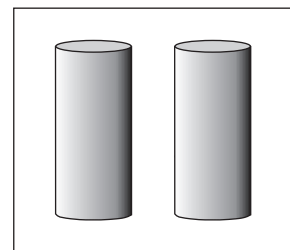
RAID level-1 requires two physical drives.

The following illustration shows an example of a RAID level-1 logical drive.

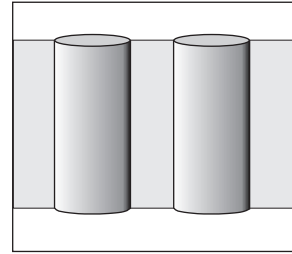
Start with two physical drives.



Create an array using the two physical drives.

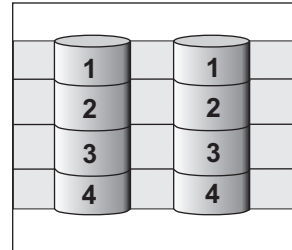


Then create a logical drive within that array.



The data is striped across the drives, creating blocks.

Notice that the data on the drive on the right is a copy of the data on the drive on the left.



With RAID level-1, if one of the physical drives fails, the ServeRAID controller switches read and write requests to the remaining functional drive in the RAID level-1 array.

RAID level-1 offers the following advantages and disadvantages.

Advantages	Disadvantages
<ul style="list-style-type: none"> • 100% data redundancy • High performance 	Allows only 50% of the physical drive storage capacity to be used

Understanding RAID level-1 Enhanced

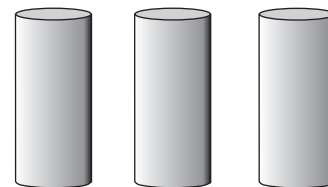
RAID level-1 Enhanced (RAID level-1E) combines mirroring and data striping. This RAID level stripes data and copies of the data across all of the drives in the array. As with the standard RAID level-1, the data is mirrored, and the capacity of the logical drive is 50% of the array capacity.

RAID level-1E has a similar profile to RAID level-1; it provides data redundancy and high levels of performance, but the storage capacity is diminished. However, RAID level-1E allows a larger number of physical drives to be used.

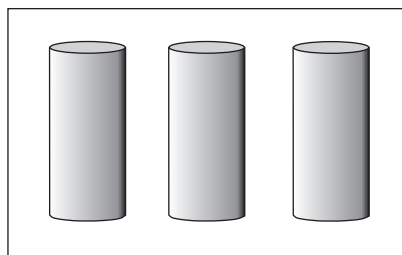
RAID level-1E requires a minimum of three drives and, depending upon the level of firmware and the stripe-unit size, supports a maximum of 8 or 16 drives.

The following illustration is an example of a RAID level-1E logical drive.

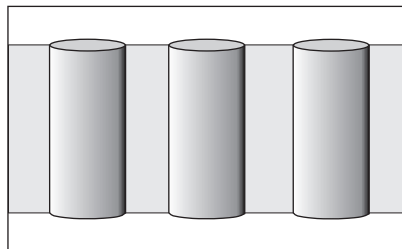
Start with three physical drives.



Create an array using the physical drives.

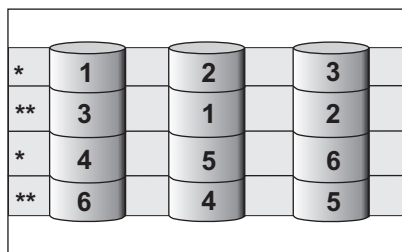


Then create a logical drive within that array.



The data is striped across the drives, creating blocks.

Notice that the stripe labeled * is the data stripe and the stripe labeled ** is the copy of the preceding data stripe. Also, notice that each block on the mirror stripe is shifted one drive.



With RAID level-1E, if one of the physical drives fails, the ServeRAID controller switches read and write requests to the remaining functional drives in the RAID level-1E array.

RAID level-1E offers the following advantages and disadvantages:

Advantages	Disadvantages
<ul style="list-style-type: none"> • 100% data redundancy • High performance 	Allows only 50% of the physical drive storage capacity to be used

Understanding RAID level-5

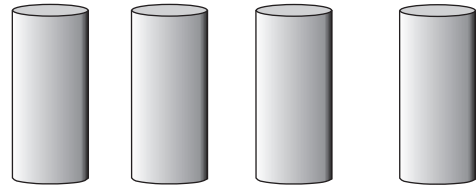
RAID level-5 stripes data and parity across all drives in the array.

RAID level-5 offers both data protection and increased throughput. When you assign RAID level-5 to an array, the capacity of the array is reduced by the capacity of one drive (for data-parity storage). RAID level-5 gives you higher capacity than RAID level-1, but RAID level-1 offers better performance.

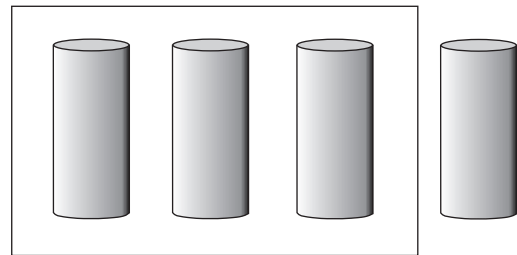
RAID level-5 requires a minimum of three drives and, depending upon the level of firmware and the stripe-unit size, supports a maximum of 8 or 16 drives.

The following illustration is an example of a RAID level-5 logical drive.

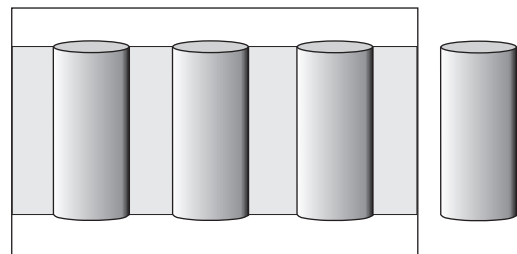
Start with four physical drives.



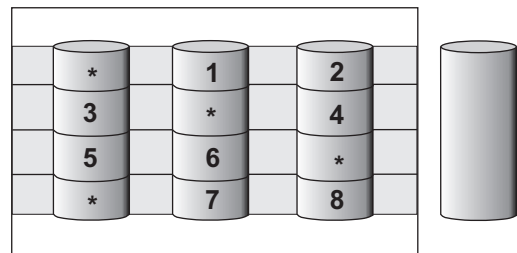
Create an array using three of the physical drives, leaving the fourth as a hot-spare drive.



Then create a logical drive within that array.



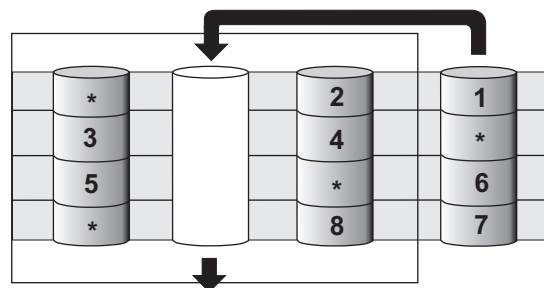
The data is striped across the drives, creating blocks.



Notice that the storage of the data parity (denoted by *) also is striped, and it shifts from drive to drive.

A parity block (*) contains a representation of the data from the other blocks in the same stripe. For example, the parity block in the first stripe contains data representation of blocks 1 and 2.

If a physical drive fails in the array, the data from the failed physical drive is reconstructed onto the hot-spare drive.



RAID level-5 offers the following advantages and disadvantages.

Advantages	Disadvantages
<ul style="list-style-type: none">• 100% data protection• Offers more physical drive storage capacity than RAID level-1 or level-1E	Lower performance than RAID level-1 and level-1E

Understanding RAID level-5 Enhanced

RAID level-5E is the same as RAID level-5 with a built-in spare drive. Like RAID level-5, this RAID level stripes data and parity across all of the drives in the array.

RAID level-5E offers both data protection and increased throughput. When an array is assigned RAID level-5E, the capacity of the logical drive is reduced by the capacity of two physical drives in the array (one for parity and one for the spare).

Reading from and writing to four physical drives is more efficient than reading from and writing to three physical drives and an idle hot spare. Therefore, RAID level-5E provides a higher level of performance than RAID level-5.

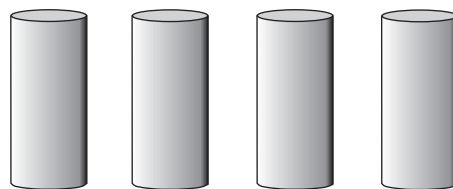
The spare drive is actually part of the RAID level-5E array, as shown in the following example. With such a configuration, you cannot share the spare drive with other arrays. If you want a spare drive for any other array, you must have another spare drive for those arrays.

RAID level-5E requires a minimum of four drives and, depending upon the level of firmware and the stripe-unit size, supports a maximum of 8 or 16 drives. RAID level-5E is also firmware-specific.

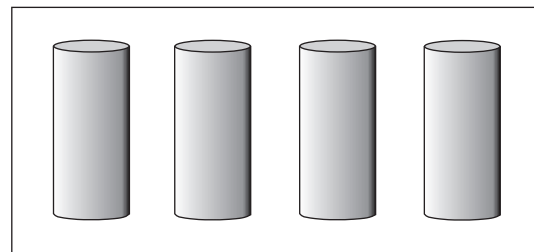
Note: For RAID level-5E, you can have only one logical drive in an array. When using RAID level-5E, you can have a maximum of seven logical drives on the controller.

The following illustration is an example of a RAID level-5E logical drive.

Start with four physical drives.

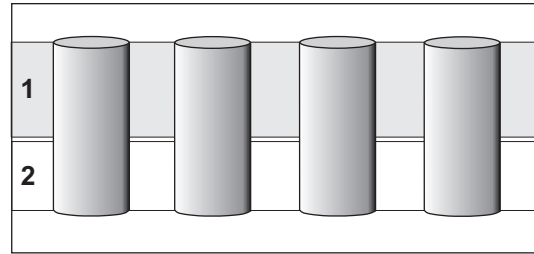


Create an array using all four physical drives.



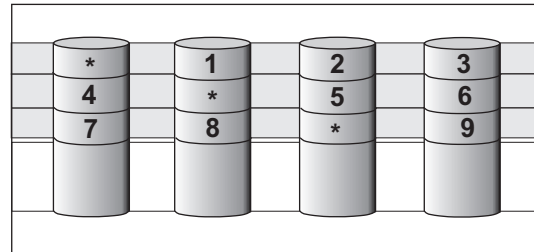
Then create a logical drive (labeled as 1) within the array.

Notice that the distributed spare drive is the free space (labeled as 2) shown below the logical drive.



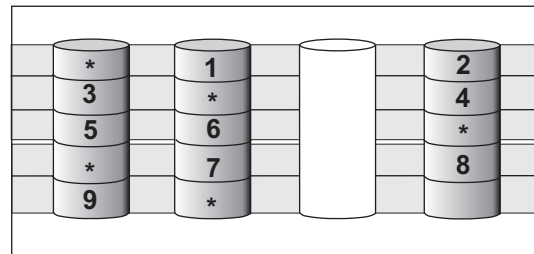
The data is striped across the drives, creating blocks in the logical drive.

The storage of the data parity (denoted by *) is striped, and it shifts from drive to drive as it does in RAID level-5.



Notice that the spare drive is *not* striped.

If a physical drive fails in the array, the data from the failed drive is reconstructed. The array undergoes compression, and the distributed spare drive becomes part of the array. The logical drive remains RAID level-5E.



When you replace the failed drive, the data for the logical drive decompresses and returns to the original striping scheme.

If you use a RAID level-5E logical drive in a failover or cluster configuration, the RAID level-5E logical drive will not failover while undergoing compression or decompression.

RAID level-5E offers the following advantages and disadvantages.

Advantages	Disadvantages
<ul style="list-style-type: none"> • 100% data protection • Offers more physical drive storage capacity than RAID level-1 or level-1E • Higher performance than RAID level-5 	<ul style="list-style-type: none"> • Lower performance than RAID level-1 and level-1E • Supports only one logical drive per array • Cannot share a hot-spare drive with other arrays

Note: The ServeRAID Manager program Configuration wizard does not default to RAID level-5E. If you have four physical drives, Express configuration defaults to RAID level-5 with a hot-spare drive.

Understanding RAID level-x0

Note: RAID level-x0 is available only on the ServeRAID-4 and ServeRAID-5i controllers.

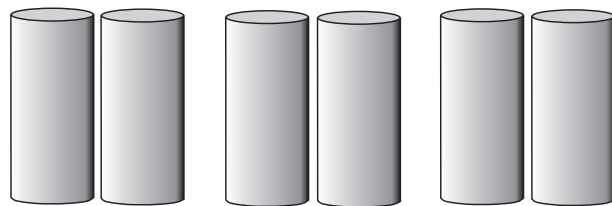
RAID level-x0 refers to RAID level-00, level-10, level-1E0, and level-50. RAID level-x0 uses an array of arrays, or a *spanned array*. The operating system uses the spanned array logical drive in the same way as a regular array logical drive.

RAID level-x0 allows more physical drives in an array. The benefits of doing so are larger logical drives, increased performance, and increased reliability. RAID level-0, level-1E, level-5, and level-5E cannot use more than 16 physical drives in an array; however, RAID level-1E0 and level-50 support 60 drives.

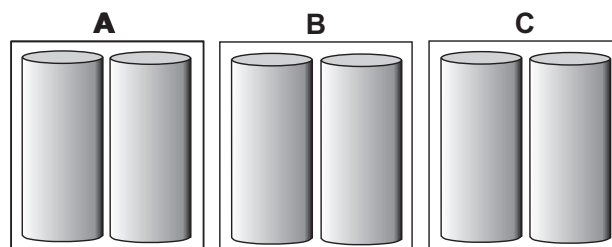
RAID level-x0 requires a minimum of two drives and supports a maximum of 60 drives.

The following illustration is an example of a RAID level-10 logical drive.

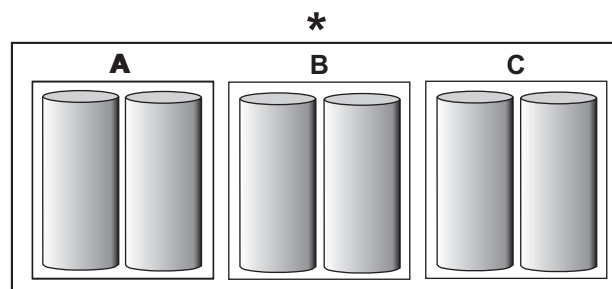
Start with six physical drives.



Create three arrays (labeled A, B, and C), each array using two physical drives.

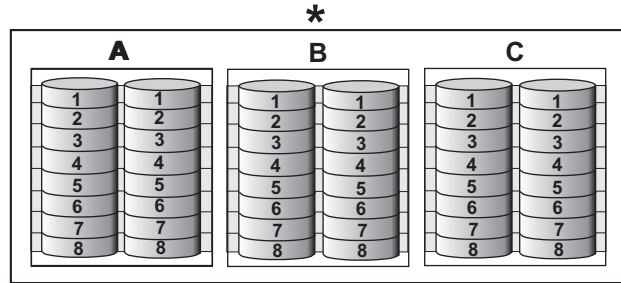


Then create a *spanned array* (labeled as *) that spans the three arrays.

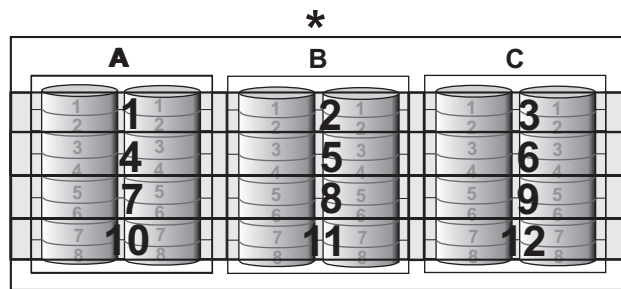


A sub-logical drive is created within *each* array (A, B, and C). Then, the data is striped across the physical drives in the array, creating blocks.

Notice that, in each array, the data on the drive on the right is a copy of the data on the drive on the left. This is because the sub-logical drives (A, B, and C) are RAID level-1 in a RAID level-10 implementation (see the following table).



Then, create a logical drive within the spanned array (*). The data is striped across this logical drive, creating blocks (1-12). Notice that none of these blocks are redundant. This is because the logical drive is RAID level-0 in a RAID level-x0 implementation (see the following table).



RAID level	Sub-logical drive	Spanned array logical drive
00	RAID level-0	RAID level-0
10	RAID level-1	RAID level-0
1E0	RAID level-1E	RAID level-0
50	RAID level-5	RAID level-0

With RAID level-10, level-1E0, and level-50, if one of the physical drives fails in a sub-logical drive, the ServeRAID controller switches read and write requests to the remaining functional drives in the sub-logical drive. With RAID level-00, a physical drive failure within the sub-logical drive results in loss of data.

RAID level-x0 offers the following advantages and disadvantages.

Advantages	Disadvantages
<ul style="list-style-type: none"> • Supports up to 60 physical drives • 100% data redundancy (except for RAID level-00) 	<ul style="list-style-type: none"> • Available only on the ServeRAID-4 and ServeRAID-5i controllers • No data redundancy for RAID level-00

Drive-state descriptions

This section provides descriptions of the physical and logical drive states. ServeRAID publications frequently refer to these states.

Physical-drive-state descriptions

The following table provides descriptions of the valid physical drive states.

Drive state	Meaning
Defunct	<p>A physical drive in the online, hot-spare, or rebuild state has become defunct. It does not respond to commands, which means that the ServeRAID controller cannot communicate properly with the drive.</p> <p>If a physical drive has become defunct, see “Rebuilding a defunct drive” on page 157.</p>
Hot spare	<p>A hot-spare drive is a physical drive that is defined for automatic use when a similar drive fails.</p>
Online	<p>The drive is online. It is functioning properly and is part of an array.</p>
Rebuilding	<p>The drive is being rebuilt.</p> <p>For more information on rebuilding a drive, see “Rebuilding a defunct drive” on page 157.</p>
Ready	<p>The ServeRAID controller recognizes a ready drive as being available for definition.</p>
Standby hot spare	<p>A standby hot spare is a hot-spare drive that the ServeRAID controller has spun down. If an online drive becomes defunct and no suitable hot-spare drive is available, a standby hot-spare drive of the appropriate size automatically spins up and enters the rebuild state.</p>

Logical-drive-state descriptions

The following table provides descriptions of the valid logical drive states.

Drive state	Meaning
Blocked	<p>The blocked state is reserved for RAID level-0 logical drives that are part of the same array as one or more of the following:</p> <ul style="list-style-type: none">• A RAID level-1 logical drive• A RAID level-1E logical drive• A RAID level-5 logical drive <p>If a physical drive in such an array fails, the RAID level-0 logical drives enter the offline state, while the other logical drives enter the critical state.</p> <p>After you replace the failed physical drive, a rebuild operation starts and reconstructs the data stored in any RAID level-1, level-1E, or level-5 logical drives; at the same time, the RAID level-0 logical drives enter the blocked state. RAID level-0 logical drives cannot be rebuilt, since they do not contain redundant data.</p> <p>After the rebuild operation is completed, you can unblock the RAID level-0 logical drives and access them once again. However, the logical drive might contain damaged data. You must re-create, reinstall, or restore the data from the most recent backup disk or tape to the RAID level-0 logical drive.</p>
Critical migrating	<p>A logical drive in the critical state that is undergoing a logical-drive migration (LDM).</p>
Critical system	<p>The ServeRAID controller uses this reserved state during a logical-drive migration when the logical drive is in the critical state.</p>

Drive state	Meaning
Critical	<p>A RAID level-1, level-1E, level-5, or level-5E logical drive that contains a defunct physical drive is in the critical state. A critical logical drive is accessible, despite a physical drive failure.</p> <p>Attention: If the state of the logical drive is critical, see “Rebuilding a defunct drive” on page 157.</p>
Migrating	<p>The logical drive is undergoing a logical-drive migration; that is, a change in RAID levels, a change in logical-drive size, an increase in free space, or a RAID level-5E compression or decompression.</p>
Offline	<p>The logical drive is offline and not accessible. This state occurs when one of the following is true:</p> <ul style="list-style-type: none"> • One or more physical drives in a RAID level-0 logical drive are defunct. • Two or more physical drives in a RAID level-1, level-1E, or level-5 logical drive are defunct. • Three or more drives in a RAID level-5E logical drive are defunct. <p>If any of these is true, see “Rebuilding a defunct drive” on page 157.</p>
Okay	<p>The logical drive is working properly. It is in a good, functional state.</p>
System	<p>The ServeRAID controller uses this reserved state during logical-drive migration.</p>

Chapter 4. Configuring ServeRAID controllers

This chapter provides information about obtaining ServeRAID updates, updating ServeRAID BIOS and firmware code, and configuring ServeRAID controllers.

Obtaining ServeRAID updates

IBM periodically makes updated versions of the ServeRAID software available from the IBM Support page on the World Wide Web.

Complete the following steps to locate files:

1. Go to <http://www.ibm.com/pc/support/>.
2. In the **Search** field at the top of the page, type ServeRAID; then, press Enter.

Note: If you download ServeRAID software, you must download and install *all* ServeRAID software at the same time. This will ensure that all levels of the software are compatible. The ServeRAID software includes the following:

- BIOS and firmware code
- Device drivers
- ServeRAID Manager program
- Command-line programs

If you do not have access to the World Wide Web, contact your place of purchase, your IBM reseller, or your IBM marketing representative for replacement CDs.

Updating BIOS and firmware code

Before configuring the ServeRAID controller, you must have the latest BIOS and firmware code installed on your server. Complete the following steps to update the levels of BIOS and firmware code:

1. Insert the *IBM ServeRAID Support* CD into the server CD-ROM drive, and turn on the server.

The IBM ServeRAID ROM Update Wizard automatically starts. The IBM ServeRAID ROM (read-only memory) Update Wizard is a program that updates the BIOS and firmware code on ServeRAID controllers. The wizard automatically identifies and scans each ServeRAID controller.

If the BIOS and firmware code do not require updating, the wizard automatically stops and the ServeRAID Manager program starts. Continue with “Configuring the ServeRAID controller” on page 36.

If the BIOS and firmware code require updating, a report screen opens with the following information:

- Controller types found.
- Controller slot number, if known.
- Firmware version.
- BIOS version.
- Update status. If a controller has outdated BIOS or firmware code, the IBM ServeRAID ROM Update Wizard marks the controller as a candidate for update.

The IBM ServeRAID ROM Update Wizard asks if you want to update. You decide whether to update, but you must update all or none of the controllers in your server; you cannot selectively update.

2. If you want to update your ServeRAID controllers, click **Update**. If the wizard detects an error, an error message appears and you are prompted to insert a diskette into your diskette drive. The wizard saves details about the error to a file on the diskette.
If you do not want to update your ServeRAID controllers, click **Cancel**.
3. When all updates are completed, scroll through the Features window. This window reports the changes that the IBM ServeRAID ROM Update Wizard applied to your ServeRAID controllers.
4. Leave the *IBM ServeRAID Support* CD in the CD-ROM drive; shut down and restart the server.

Configuring the ServeRAID controller

This section provides information about starting and using the ServeRAID Manager program. You can use the ServeRAID Manager program to configure your ServeRAID controllers, view the ServeRAID configurations and associated devices, change controller settings, monitor your controllers, and more.

The information in this section focuses on using the ServeRAID Manager program in startable-CD mode to configure your controllers or to change specific settings. For information about other uses of ServeRAID Manager, see the ServeRAID Manager online help.

If you are configuring an integrated RAID controller, see the instructions in the *Installation Guide* provided with your server.

Important

If you intend to use your ServeRAID-4 controllers in a Microsoft Windows failover or clustering environment, do the following:

- For failover, go to Chapter 6, “Configuring two ServeRAID controllers in a failover environment” on page 51.
- For clustering, go to Part 3, “Installing the IBM ServeRAID Cluster Solution” on page 101.

Using ServeRAID Manager

The ServeRAID Manager program operates in two ways:

- Startable-CD mode
- As an installed software program

When you run the ServeRAID Manager program from the startable *IBM ServeRAID Support* CD, you are using startable-CD mode. Startable-CD mode lets you to configure your controller *before* you install your operating system. After you have configured the controller and installed the operating system, you also can use startable-CD mode to change specific controller settings. For additional information, see “Viewing your configuration” on page 44.

To run the ServeRAID Manager program in startable-CD mode, turn on the server; then, insert the *IBM ServeRAID Support* CD (or the CD that contains the ServeRAID Manager program that came with your server) into the CD-ROM drive.

If the ServeRAID Manager program detects unconfigured controllers and ready drives, the program automatically starts the Configuration wizard, and a window similar to that shown in Figure 10 on page 37 opens.

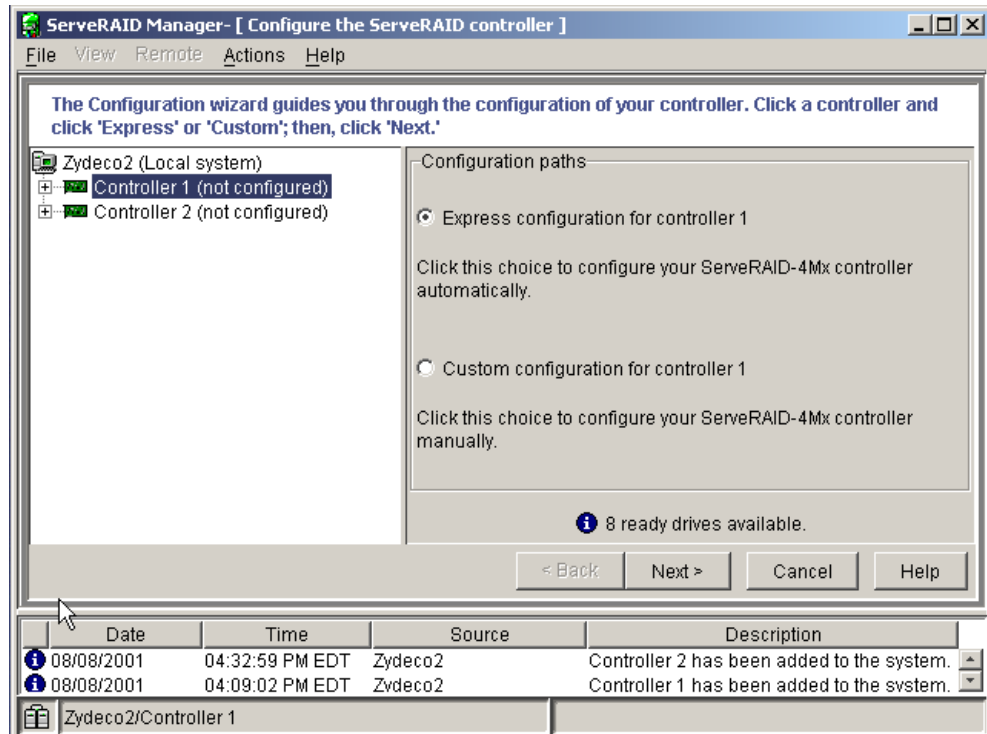


Figure 10. "Configuration wizard" window

You can use the Configuration wizard to create up to eight arrays and up to eight logical drives for each ServeRAID controller. The Configuration wizard provides two configuration options: Express and Custom. Express configuration automatically configures your ServeRAID controller, and you can use Custom configuration to configure your controller manually. If you want to use RAID level-1E, RAID-level-5E, or RAID level-x0, you must use Custom configuration. For more information about RAID levels, see Chapter 3, "Understanding RAID technology" on page 21.

Using Express configuration

Express configuration automatically configures your ServeRAID controller. This feature does the following:

- Creates arrays by grouping together same-sized physical drives.
- Creates one logical drive per array.
- Assigns a RAID level based on the number of physical drives in an array:
 - An array with a single physical drive is assigned RAID level-0.
 - An array with two physical drives is assigned RAID level-1.
 - An array with three or more physical drives is assigned RAID level-5.
- Designates a hot-spare drive for the controller. If one or more arrays has four or more physical drives, the largest-sized drive from those arrays is designated the hot-spare drive.

Complete the following steps to use Express configuration:

1. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure.
2. Click **Express configuration**.
3. Click **Next**. The "Configuration summary" window opens.

- Review the information that is displayed in the “Configuration summary” window. To change the configuration, click **Modify arrays** or **Modify logical drives**.

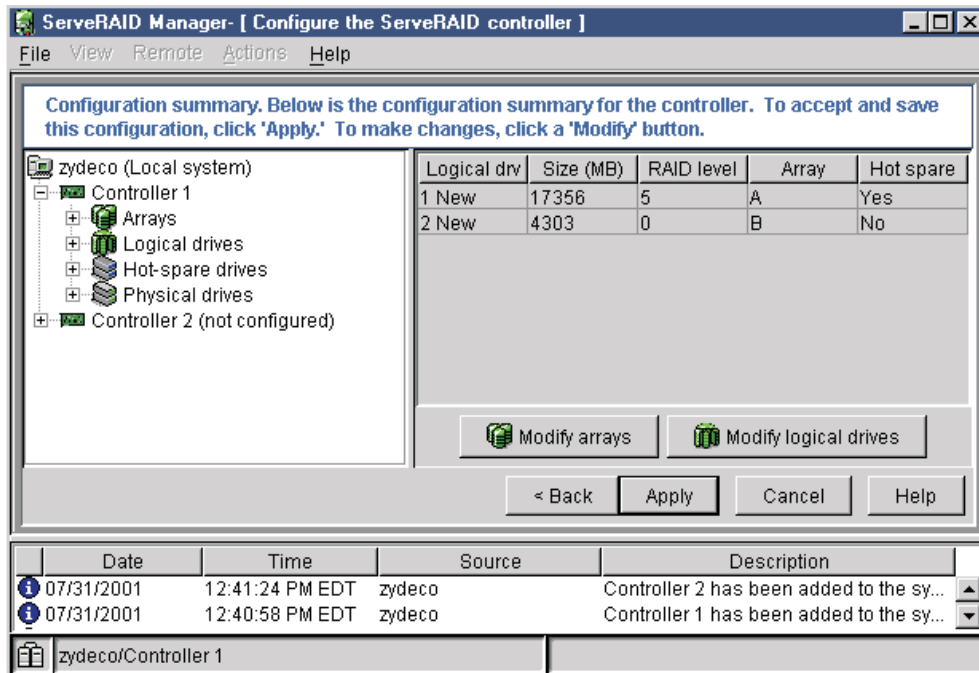



Figure 11. “Configuration summary” window (Express Configuration)

Note: Some operating systems have size limitations for logical drives. Before you save the configuration, verify that the size of the logical drive is appropriate for your operating system.

- Click **Apply**; then, click **Yes** when asked if you want to apply the new configuration. The configuration is saved in the ServeRAID controller and in the physical drives.
- If you have multiple controllers, do the following:
 - Click the ServeRAID controller that you want to configure.
 - From the toolbar, click  (Configure RAID).
 - Repeat steps 2 on page 37 through 6 for each controller.
- When you have completed configuring your controllers, you can change certain controller settings. See “Fine-tuning your configuration” on page 43 for more information. If you do not want to change any settings, exit from the ServeRAID Manager program, and remove the CD from the CD-ROM drive.
- Restart the server.
- Continue with Chapter 5, “Installing ServeRAID device drivers” on page 49.

Note: If you are configuring your startup (boot) ServeRAID controller, you *must* install the device driver while installing the operating system.

Using Custom configuration

Select Custom configuration to configure your controller manually. Complete the following steps to use Custom configuration:

- In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure.

2. Click **Custom configuration**.
3. Click **Next**. The “Create arrays” window opens. If you want to create spanned arrays, go to step 2 of “Creating spanned arrays” on page 42.

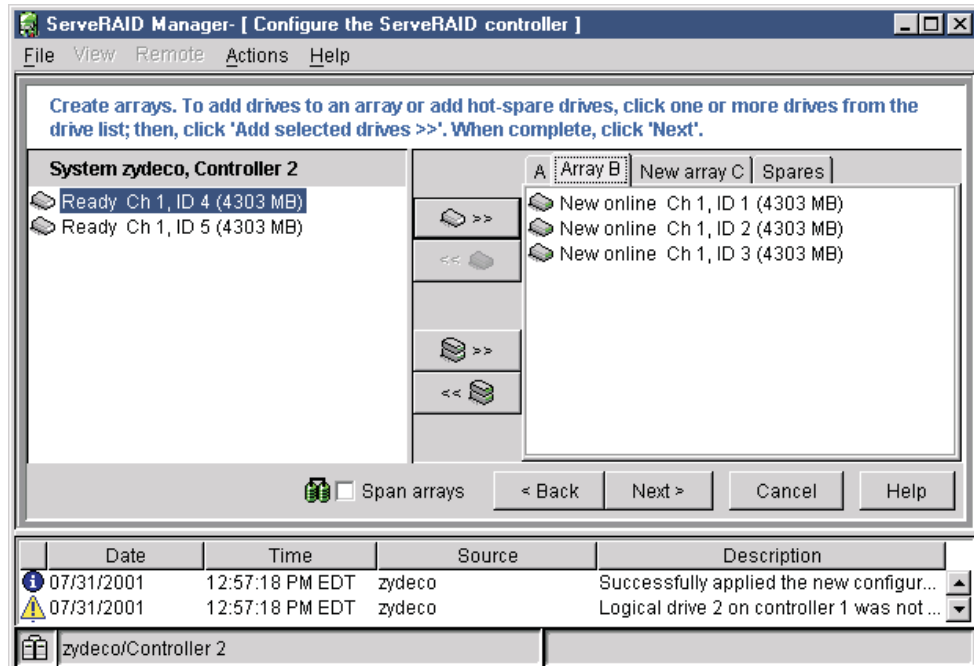




Figure 12. “Create arrays” window

4. Click the appropriate tab in the right pane; then, from the list of ready drives, select the drives you want to move to the array.
5. Click  >> (Add selected drives) to add the drives to the array. You can click  >> (Add all drives) to move *all* ready drives to an array.
6. Repeat steps 4 and 5 for each additional array or hot-spare drive that you want to configure.
7. After you select the ready drives for your arrays and hot-spare drive, click **Next**. The “Create logical drives” window opens.

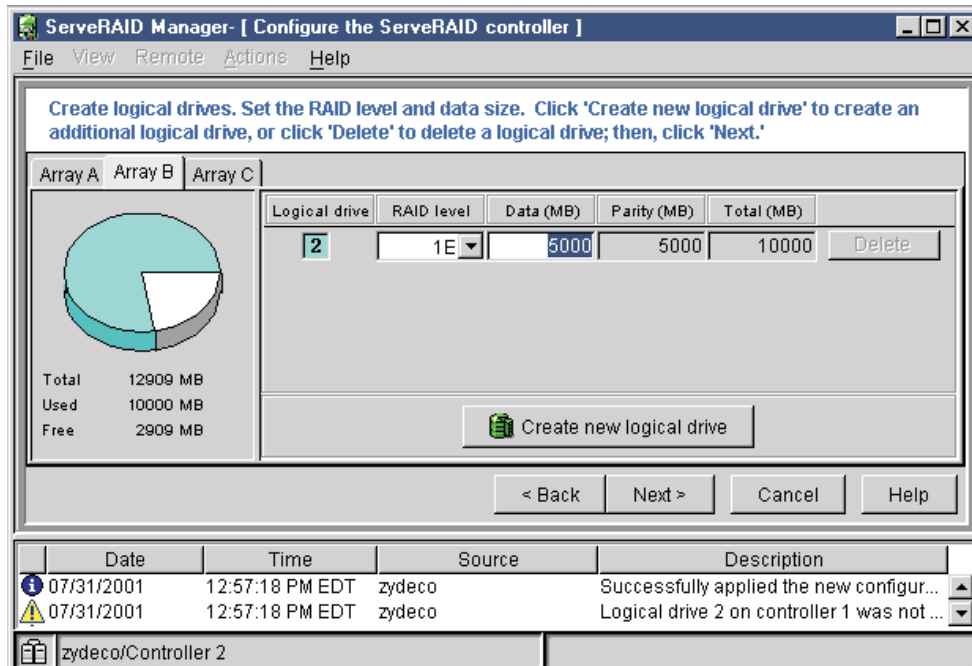


Figure 13. “Create logical drives” window

8. Click the appropriate **Array** tab.
9. Select a RAID level from the drop-down list. (For more information, see “Supported RAID levels” on page 22.)

Notes:

- a. RAID level-5E allows only one logical drive per array.
 - b. If you are configuring a spanned array, you can set the RAID level only for the first logical drive you create.
10. If you do not want to use the maximum size for the logical drive, type the size in the **Data (MB)** field.

Notes:

- a. You can define up to eight logical drives per controller. There are two exceptions:
 - If an array contains a logical drive assigned RAID level-5E
 - If you want to use the logical-drive migration feature

In these cases, one logical drive slot must be left free; therefore, you cannot define more than seven logical drives.
 - b. Some operating systems have size limitations for logical drives. Before you save the configuration, verify that the size of the logical drive is appropriate for your operating system.
 - c. A logical drive cannot exceed 2048 GB.
 - d. Typically, the first logical drive defined on the first ServeRAID controller found by system BIOS during startup will be your startup (boot) drive.
11. If you have free space available and want to create additional logical drives, click **Create new logical drive**.

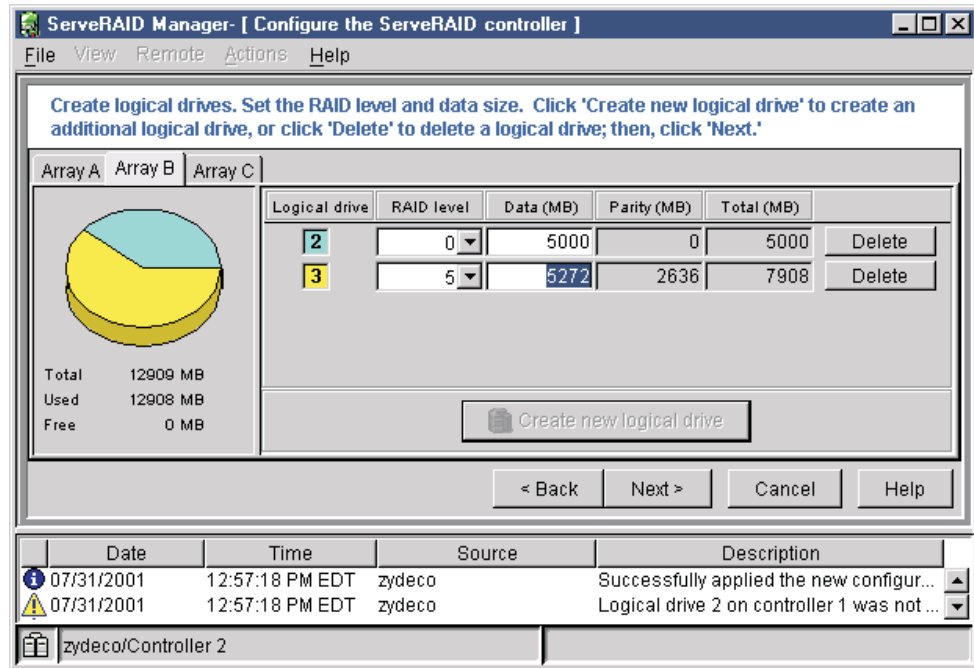


Figure 14. "Adding another logical drive" window

12. Repeat steps 9 through 11 on page 40 for each logical drive that you want to define in this array.
13. Repeat steps 8 on page 40 through 12 for each additional array you want to configure.
14. Click **Next**. The "Configuration summary" window opens.

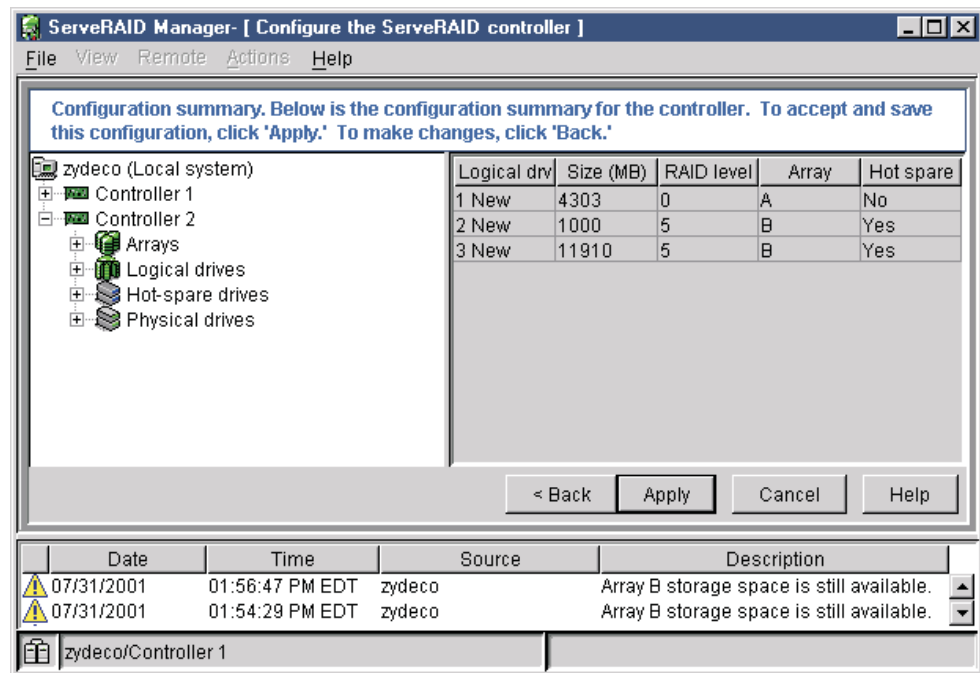



Figure 15. "Configuration summary" window (Custom Configuration)

15. Review the information that is displayed in the “Configuration summary” window. To change the configuration, click **Back**.
16. Click **Apply**; then, click **Yes** when asked if you want to apply the new configuration. The configuration is saved in the ServeRAID controller and in the physical drives.
17. If you have multiple controllers, do the following:
 - a. Click the ServeRAID controller that you want to configure.
 - b. From the toolbar, click  (Configure RAID).
 - c. Repeat steps 2 on page 39 through 17b for each controller.
18. When you have completed configuring your controllers, you can change certain controller settings. See “Fine-tuning your configuration” on page 43 for more information. If you do not want to change any settings, exit from the ServeRAID Manager program, and remove the CD from the CD-ROM drive.
19. Restart the server.
20. Continue with Chapter 5, “Installing ServeRAID device drivers” on page 49.


Note: If you are configuring your startup (boot) ServeRAID controller, you *must* install the device driver while installing the operating system.

Creating spanned arrays: If you want to assign RAID level-x0 to an array, you must create a spanned array. For more information about spanned arrays, see “Understanding RAID level-x0” on page 30.


Notes:

1. Spanned arrays are supported only by ServeRAID-4 and ServeRAID-5i controllers.
2. A logical drive cannot exceed 2048 GB.

Complete the following steps to create one or more spanned arrays:

1. If you have not completed steps 1 to 3 in “Using Custom configuration” on page 38, do so now.
2. Create identical arrays by doing the following:
 - a. Click the **Array** tab in the right panel; then, from the list of ready drives, select the drives you want to move to the array.
 - b. Click  (Add selected drives) to add the drives to the array.
 - c. Repeat steps 2a and 2b for each additional array that you want to configure.

Note: To create a spanned array, the arrays to be spanned must be identical (that is, they must have the same number of physical drives).

- d. Select the  **Span arrays** check box; then, click **Next**. The “Create spanned arrays” window opens.

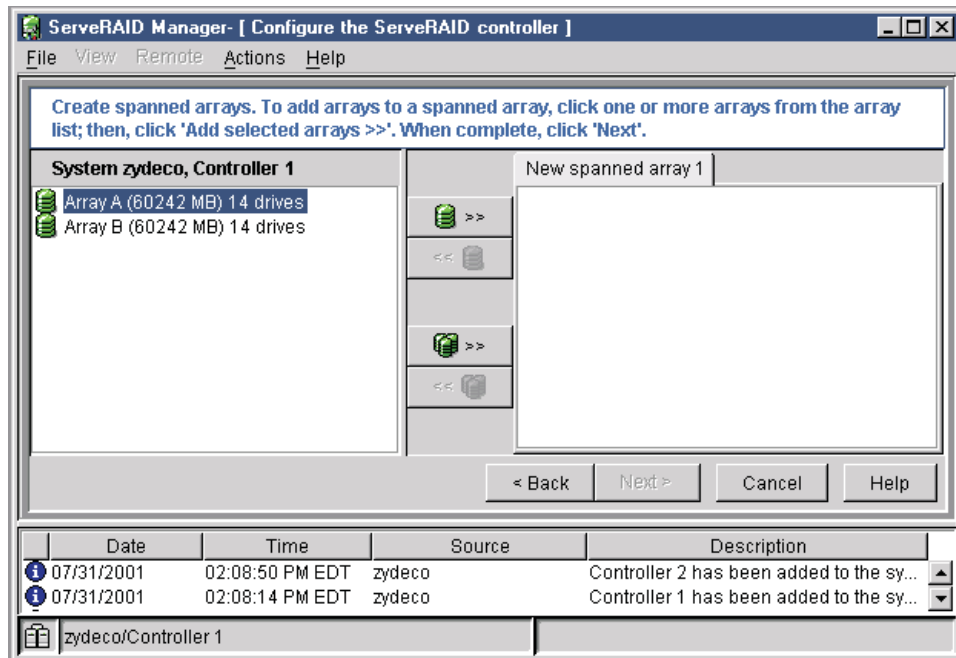




Figure 16. “Create spanned arrays” window

3. Create spanned arrays by doing the following:
 - a. In the list of arrays, click the arrays that you want to add to your spanned array.
 - b. Click  (Add selected arrays) to add the arrays to the spanned array. You can click  (Add all arrays) to move *all* arrays to the spanned array.
 - c. To create additional spanned arrays, click the **New spanned array** tab in the right pane; then, repeat steps 3a and 3b.
4. Click **Next**; the “Create logical drives” window opens. Continue with step 8 of “Using Custom configuration” on page 38.

Fine-tuning your configuration

Before you store data on the controller, you will need to determine the correct stripe-unit size for your configuration and set the write-cache mode, if necessary.

Changing the stripe-unit size

The new controller stripe-unit size is set at the factory to 8 KB. If you need to change this setting, you *must* change the stripe-unit size before you store data in the logical drives. After you store data in the logical drives, you cannot change the stripe-unit size without destroying data in the logical drives.

Complete the following steps to change the stripe-unit size:

1. In the ServeRAID Manager tree, click the new controller to select it.
2. Click **Actions** → **Change stripe-unit size**.

3. Select the new stripe-unit size for your installation.

Note: Consider your server application environment when you select the controller stripe-unit size setting.

Environment	Stripe-unit size
Groupware (such as Lotus® Notes® or Exchange)	16 KB
Transaction processing database	16 KB
Decision support database	16 KB
Thin client environments	8 KB
File server (Windows 2000, Windows NT 4.0, Novell NetWare)	16 KB
File server (other)	8 KB
Web server	8 KB
Other	8 KB

Write-cache mode

If you are preparing to install Novell NetWare 5.x from the startable *Novell NetWare 5.x* CD, set the write-cache mode to write through for the logical drive to which you will install the operating system. To accomplish this, complete the following steps:

1. In the ServeRAID Manager tree, click the logical drive.
2. Click **Actions** → **Change write-cache mode to write through**.

Viewing your configuration

You can use ServeRAID Manager to view information about RAID controllers and the RAID subsystem (such as arrays, logical drives, hot-spare drives, and physical drives).

To view information, expand the ServeRAID Manager tree; then, click the relevant tree object. Detailed information about the selected device appears in the right pane.

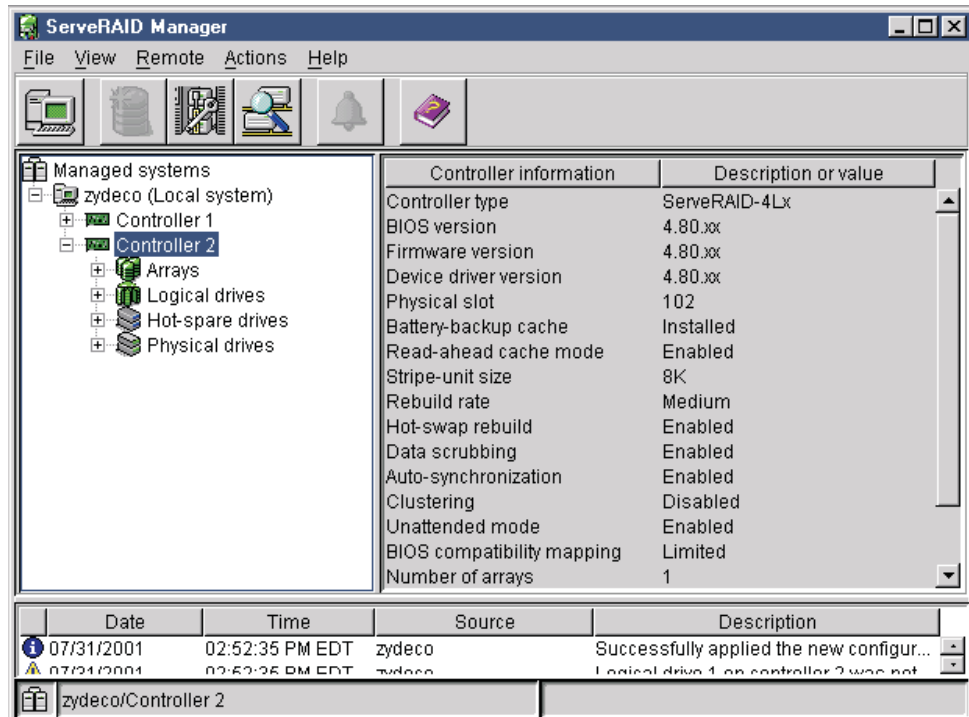



Figure 17. ServeRAID Manager window

To display available actions for an item, click the item in the ServeRAID Manager tree and click **Actions**.

Getting assistance

For more information about ServeRAID Manager, see the online help system. To start the help system, either click  (Information about this window) on the toolbar or select an item from the **Help** menu.

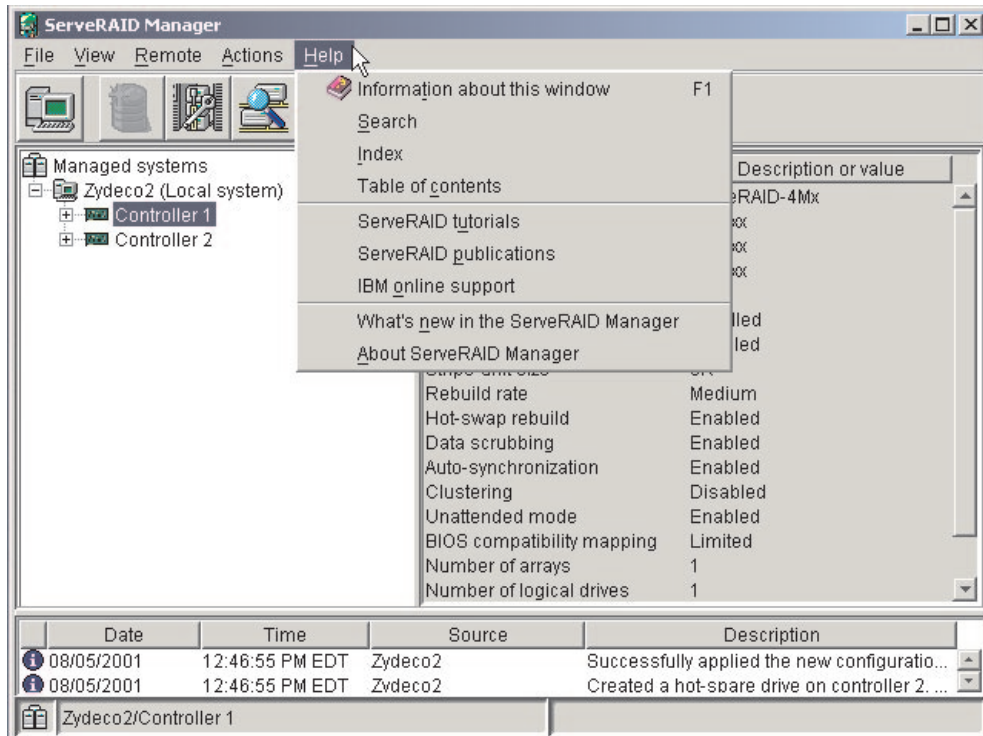


Figure 18. ServeRAID Manager help menu

The help system (ServeRAID Assist) will open within the ServeRAID Manager interface.

To learn more about the ServeRAID Manager tree objects and the actions that apply to them, select a tree object and click **Actions** → **Hints and tips**. ServeRAID Assist will start, and information about the tree object will appear in the right pane of ServeRAID Manager.

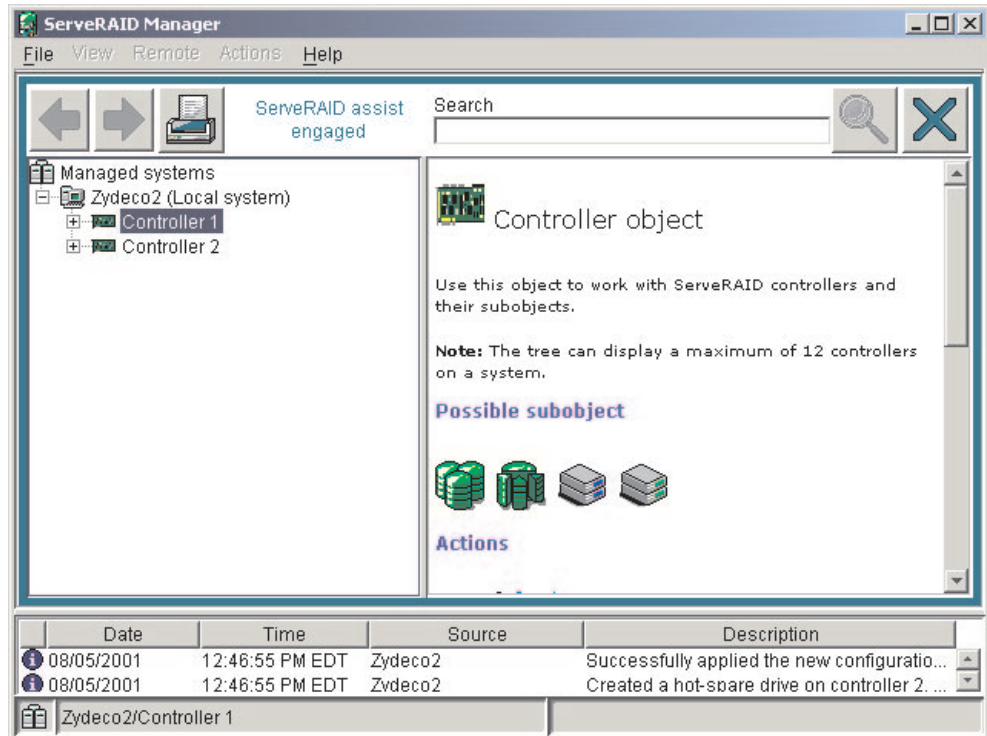


Figure 19. Hints and tips feature

Chapter 5. Installing ServeRAID device drivers

The ServeRAID device drivers are provided on the *IBM ServeRAID Support CD*. The *IBM ServeRAID Device Driver Installation Instructions* (DEVDRV51.PDF), located in the /BOOKS directory on the *IBM ServeRAID Support CD*, provides detailed instructions for installing the device drivers on the following operating systems:

- Microsoft XP Professional (ServeRAID-4Lx controller only)
- Microsoft Windows 2000 Advanced Server, Datacenter, and Server
- Microsoft Windows 2000 Professional (ServeRAID-4Lx controller only)
- Microsoft Windows NT 4.0 Enterprise Edition and Server
- Novell NetWare (versions 5.x and 6.0)
- IBM OS/2 WARP Server for e-business
- Red Hat Linux (versions 6.2, 7.0, 7.1, 7.2, and 7.3)
- SuSE Linux (versions 7.1, 7.2, and 7.3)
- Caldera OpenLinux (versions 3.1 and 3.1.1)
- Turbolinux (versions 6.5 and 7.0)
- SCO OpenServer 5.0.6a
- Caldera UnixWare 7.1.1
- Caldera Open UNIX 8.0

If you are configuring your startup (boot) ServeRAID controller, you *must* install the device driver while installing the operating system.

If you are installing files for a RAID controller that comes as a standard feature on your IBM server system board, use the installation instructions and CDs provided with your server.

Chapter 6. Configuring two ServeRAID controllers in a failover environment

You can configure two ServeRAID controllers in a failover environment when using Microsoft Windows 2000 or Microsoft Windows NT 4.0. This ServeRAID release includes an optional ServeRAID device driver that provides fault-tolerance. With fault tolerance, you can pair two controllers and connect them to the same enclosure to ensure access to the physical drives, even after one controller fails.

Hardware requirements

Important

To implement fault tolerance, you must use only matched pairs of controllers. The controllers must be identical, including stripe-unit size and the level of BIOS and firmware code.

You can use the following pairs to provide fault tolerance:

- Two ServeRAID-4H
- Two ServeRAID-4M
- Two ServeRAID-4Mx
- Two ServeRAID-4L
- Two ServeRAID-4Lx
- Two ServeRAID-3HB
- Two ServeRAID-3H
- Two ServeRAID-3L
- Two ServeRAID-II

Note: If your system has a built-in ServeRAID controller on the system board, you cannot use the built-in controller in the failover pair.

To use fault-tolerant technology with ServeRAID controllers, you must use one of the following enclosures:

- IBM Netfinity EXP15 Storage Enclosure
- IBM Netfinity EXP200 Storage Enclosure
- IBM Netfinity EXP300 Storage Enclosure

Note: You can configure only 13 physical drives in an EXP300 enclosure.

Installation guidelines and restrictions

Important

If the following guidelines and restrictions are not met, failover is disabled for the controller pair, and an error explaining the problem is logged in the system event log.

To achieve fault tolerance with ServeRAID controllers, you must adhere to the following guidelines:

- You must configure the controllers as an active-passive pair, where all logical drives are defined on only the active controller.

- The stripe-unit size and level of BIOS and firmware code must be the same on both controllers.
- All physical drives must be configured in arrays. A failover pair must not contain any physical drives in the ready state.
- You must set the write-cache mode of all logical drives on the active controller to write through.

Note: If your ServeRAID controller has a battery-backup cache, it is disabled when you create a failover pair. The write-cache mode is automatically changed from write back to write through.

- All logical drives must have unique shared merge-group numbers.
- When you use multiple failover pairs in a system, each set of controllers must have unique controller and partner names.
- All on-board ServeRAID controllers must be enabled, even if the controller is not used.

The following restrictions apply:

- Hot-spare drives are not supported in a failover environment. The exception is the built-in hot-spare that is part of a RAID level-5E logical drive.
- You cannot hot add a controller and then configure it as part of a failover pair.
- A failover pair and a ServeRAID adapter defined as a Microsoft Cluster Server (MSCS) resource cannot coexist in the same server.
- A logical drive cannot failover if it is any of the following:
 - A RAID level-5 or level-5E logical drive in a critical state
 - A RAID level-5 or level-5E logical drive that is undergoing a rebuild operation
 - A RAID level-5E logical drive that is undergoing a compression or decompression operation
 - A logical drive undergoing a logical-drive migration

Preparing the active controller

This section covers the following steps:

- Step 1. Installing the ServeRAID controller that you will designate as the active controller.
- Step 2. Configuring the active controller for failover.
- Step 3. Connecting the active controller to the enclosure; then, starting the server with the *IBM ServeRAID Support CD* in the CD-ROM drive.
- Step 4. Configuring arrays and logical drives.
- Step 5. Installing the appropriate device driver.

Installing the active controller

If you have not yet installed the ServeRAID controller that you will designate as the active controller, do so now. For instructions, see the *IBM Installation Guide* that came with the controller.

Important

Do not install the controller you will designate as the passive controller until instructed to do so.

Configuring the active controller

Complete the following steps to configure the active controller:

1. Turn on the server.

Note: The cables to the drive enclosure *must not* be attached when you start the server.

2. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive. The ServeRAID Manager program starts.
3. If the ServeRAID Manager program starts the Configuration wizard, a window similar to the following opens. Click **Cancel** to exit the Configuration wizard; then, in the confirmation window, click **Yes**.

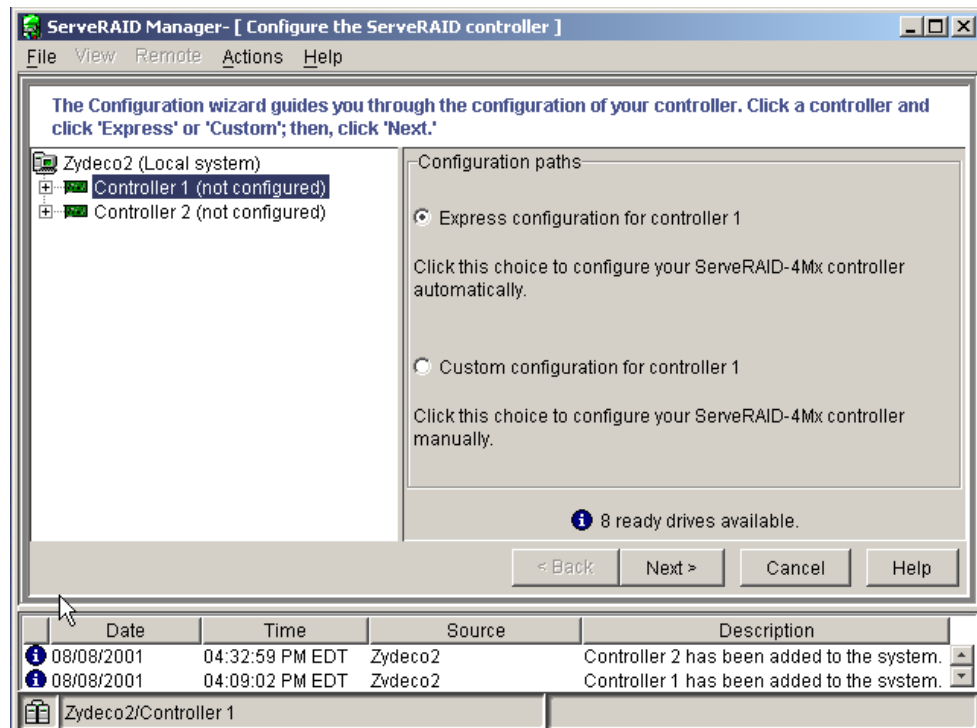


Figure 20. Configuration wizard


4. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure as the active controller.

Attention

Restore the ServeRAID controller to factory-default settings only once, when the controller is first installed. This process removes all configuration information from NVRAM, including the SCSI initiator IDs, the controller and partner names, and the array information.

This point is especially important if the Windows 2000 or Windows NT 4.0 system startup drive is attached to the IBM ServeRAID controller. If this process occurs after the startup-drive array has been created, the array information will be removed, and the system will no longer start in Windows 2000 or Windows NT 4.0.

If you already have logical drives defined on the controller that you want to keep, go to step 7. Steps 5 on page 54 and 6 on page 54 will cause loss of data by deleting all logical drives already defined.

5. Click **Actions** → **Restore to factory-default settings**.
6. If a confirmation window opens, click **Yes**. When the operation is complete, a message appears at the bottom of the window indicating that the ServeRAID Manager has successfully restored the configuration to the factory-default settings.
7. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure as the active controller.
8. Click  (Configure for clustering) on the toolbar. The “Configure controller 1 for clustering” window opens.

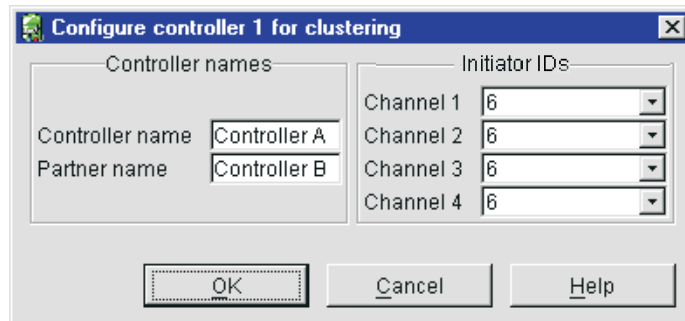


Figure 21. “Configure controller 1 for clustering” window

9. Provide the following information:

Controller name

Type a name to identify the active controller, for example, Controller A.

Partner name

Type a name that you will use to identify the passive controller, for example, Controller B.

Initiator IDs

The system presets these SCSI initiator IDs to 7. Set each ID to 6 for shared channels. (The ServeRAID Manager program does not permit you to select numbers other than 6 and 7.)

Notes:

- a. The controller name and partner name are case sensitive.
- b. If your configuration will contain multiple ServeRAID controller pairs, each controller name must be unique.

10. Click **OK**.
11. Shut down the server.

Connecting the active controller to the enclosure

Complete the following steps to connect the active controller to the enclosure:

1. Connect the enclosure to the active ServeRAID controller.


Notes:

- a. Both the active and passive controller *must* be connected to the same enclosure.

- b. The enclosure bus cables *must* be connected to the same channel on each controller. For example, the enclosure bus #1 cable is connected to Channel 1 on the active controller, and the enclosure bus #2 cable is connected to Channel 1 on the passive controller
2. Restart the server with the *IBM ServeRAID Support CD* (or the configuration CD that came with your server) in the CD-ROM drive.

Configuring ServeRAID arrays and logical drives

Complete the following steps to configure arrays and logical drives on the active controller:

1. On the toolbar, click  (Configure RAID). The Configuration wizard opens.

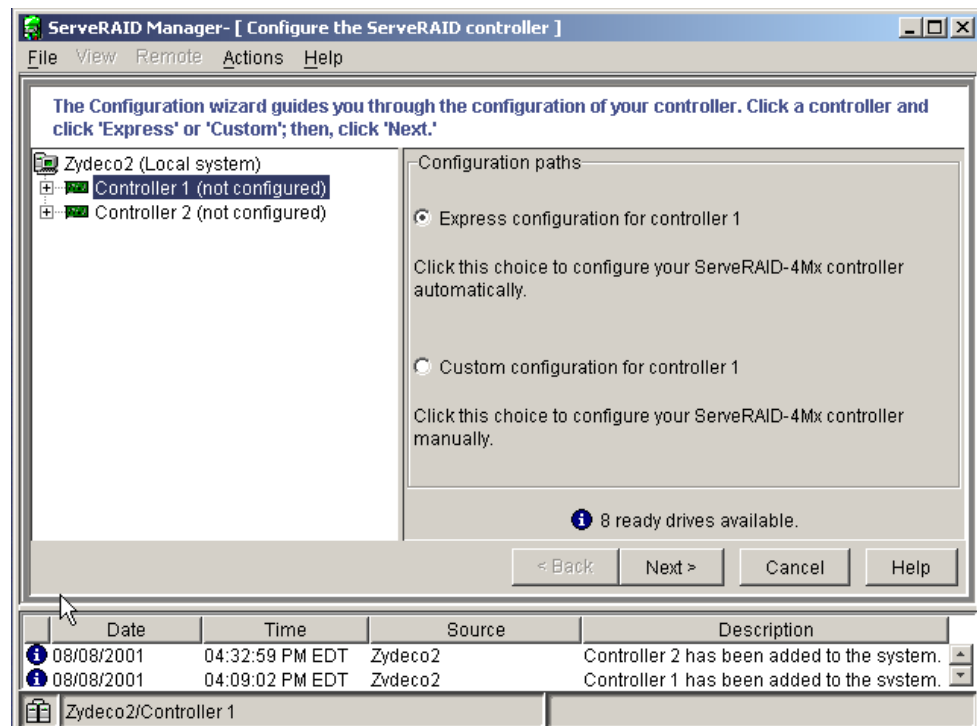


Figure 22. Configuration wizard

2. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure as the active controller.
3. Click **Custom configuration**.
4. Click **Next**. The “Create arrays” window opens. If you want to create spanned arrays, go to step 2 of “Creating spanned arrays” on page 59.

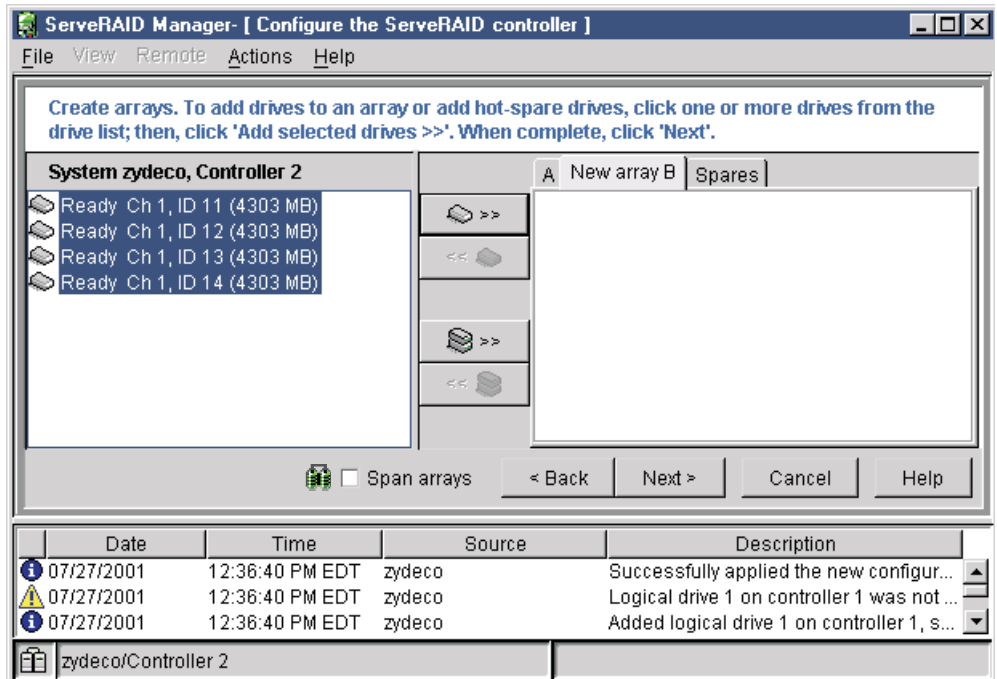




Figure 23. “Create arrays” window

5. Click the appropriate **Array** tab in the right panel; then, from the ready drives list, select the drives that you want to move to the array.
6. Click  (Add selected drives) to add the drives to an array. You can click  (Add all drives) to move *all* ready drives to an array.
7. Repeat steps 5 and 6 for each additional array that you want to configure.

Notes:

- a. You must use all the ready drives when creating your arrays (that is, all ready drives in the ServeRAID Manager tree must be online).
 - b. Hot-spare drives are not supported in a failover environment. The exception is the built-in hot-spare that is part of a RAID level-5E logical drive.
8. After you select the ready drives for your arrays, click **Next**. The “Create logical drives” window opens.

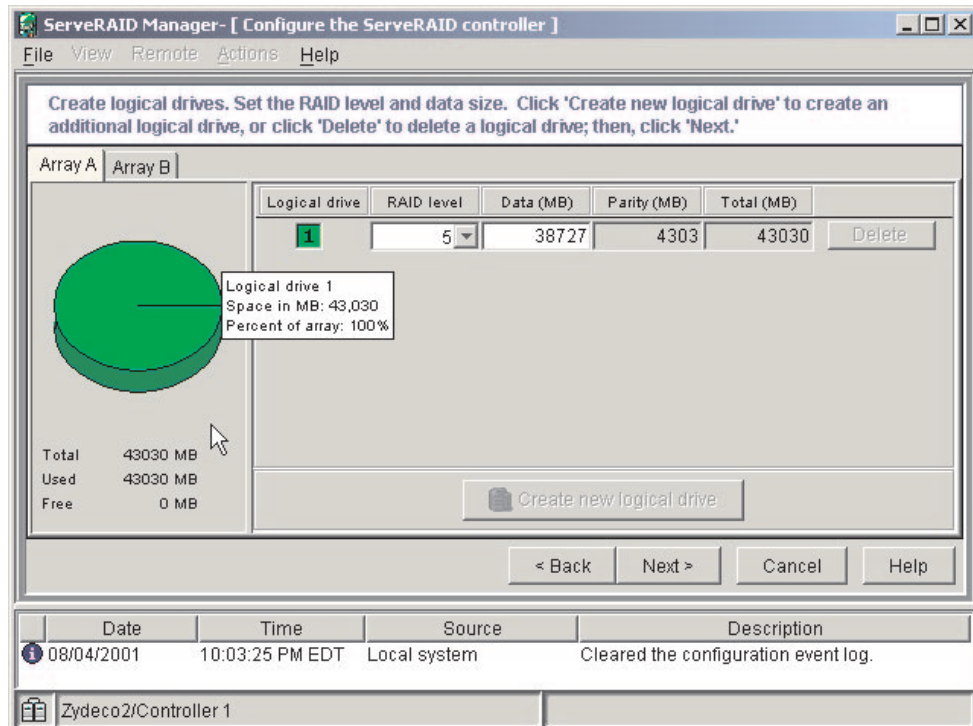


Figure 24. “Create logical drives” window

9. Click the appropriate **Array** tab.
10. Select a RAID level from the drop-down list. (For more information, see Chapter 3, “Understanding RAID technology” on page 21.)

Notes:

- a. Create only one logical drive for each array.
- b. A logical drive cannot exceed 2048 GB.
- c. Typically, the first logical drive defined on the first ServeRAID controller found by system BIOS during startup will be your startup (boot) drive.

Attention: Before assigning a logical drive RAID level-5E, consider the following. If a physical drive fails during a post-failover resynchronization, the logical drive will enter the blocked state. Data might be lost or damaged.

11. Repeat steps 9 and 10 for each additional array you want to configure.
12. Click **Next**. The “Configuration summary” window opens.

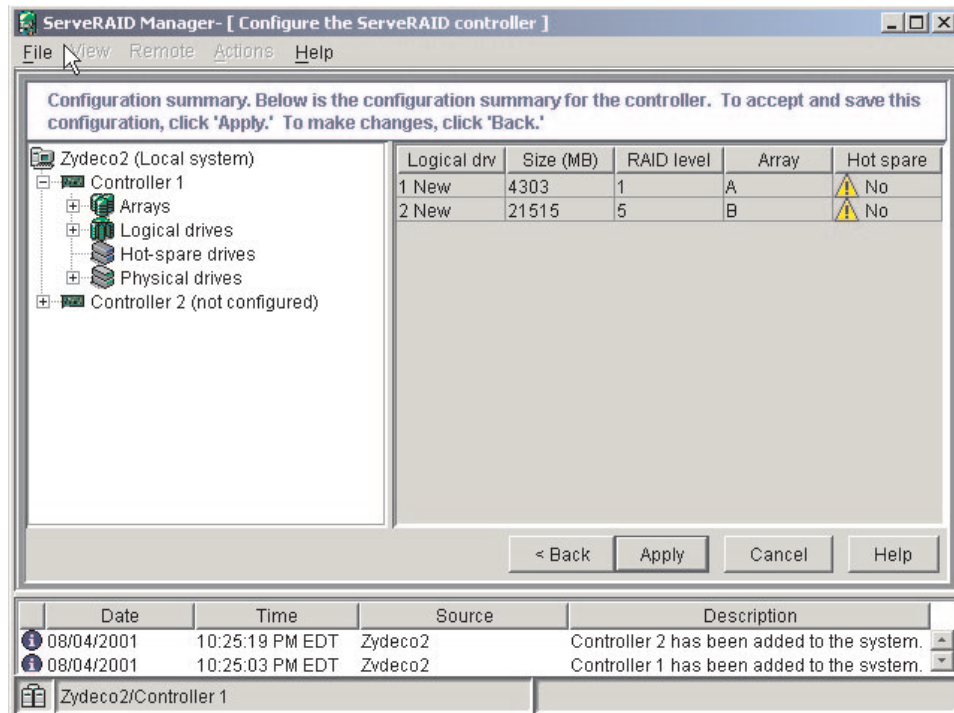



Figure 25. "Configuration summary" window

13. Review the information that is displayed in the "Configuration summary" window. To change the configuration, click **Back**.
14. Click **Apply**; then, click **Yes** when asked if you want to apply the new configuration. The configuration is saved in the ServeRAID controller and on the physical drives.
15. Click **Continue** to return to ServeRAID Manager. After creating the arrays and logical drives, you must assign merge-group numbers to the shared logical drives.
16. In the ServeRAID Manager tree, click the active controller (that is, the ServeRAID controller that contains the logical drives).
17. Click  (Configure for clustering) on the toolbar. The "Configure controller for clustering" window opens.

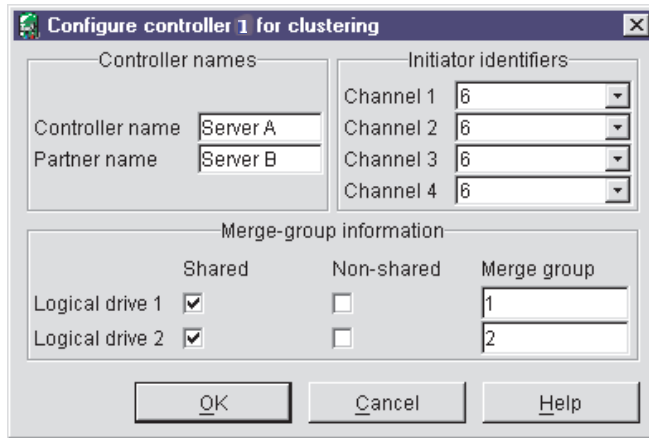


Figure 26. “Configure controller 1 for clustering” window

18. Select the **Shared** check boxes for all the logical drives.
19. Do *not* change the merge-group number from the default provided.
20. Record the controller name, partner name, and merge-group numbers; store them in a safe place. You will need this information to recover the configuration if the ServeRAID controller fails.

Note: You can save this information to a file by using the ServeRAID Manager program:


- a. In the ServeRAID Manager tree, click the server.
 - b. Click **Actions** → **Save printable configuration**.
21. Click **OK**.
 22. To exit the ServeRAID Manager program, click **File** → **Exit**.

Creating spanned arrays


If you want to assign RAID level-x0 to an array, you must create a spanned array. For more information about spanned arrays, see Chapter 3, “Understanding RAID technology” on page 21.

Note: In a failover environment, spanned arrays are supported only by IBM ServeRAID-4 Ultra160 SCSI controllers.

Complete the following steps to create one or more spanned arrays:

1. If you have not completed steps 1 through 4 in “Configuring ServeRAID arrays and logical drives” on page 55, do so now.
2. Create identical arrays by doing the following:
 - a. Click the **Array** tab in the right panel; then, from the list of ready drives, select the drives you want to move to the array.
 - b. Click  >> (Add selected drives) to add the drives to the array.
 - c. Repeat steps 2a and 2b for each additional array that you want to configure.

Note: To create a spanned array, the arrays to be spanned must be identical (that is, they must have the same number of physical drives).

- d. Select the  **Span arrays** check box; then, click **Next**. The “Create spanned arrays” window opens.

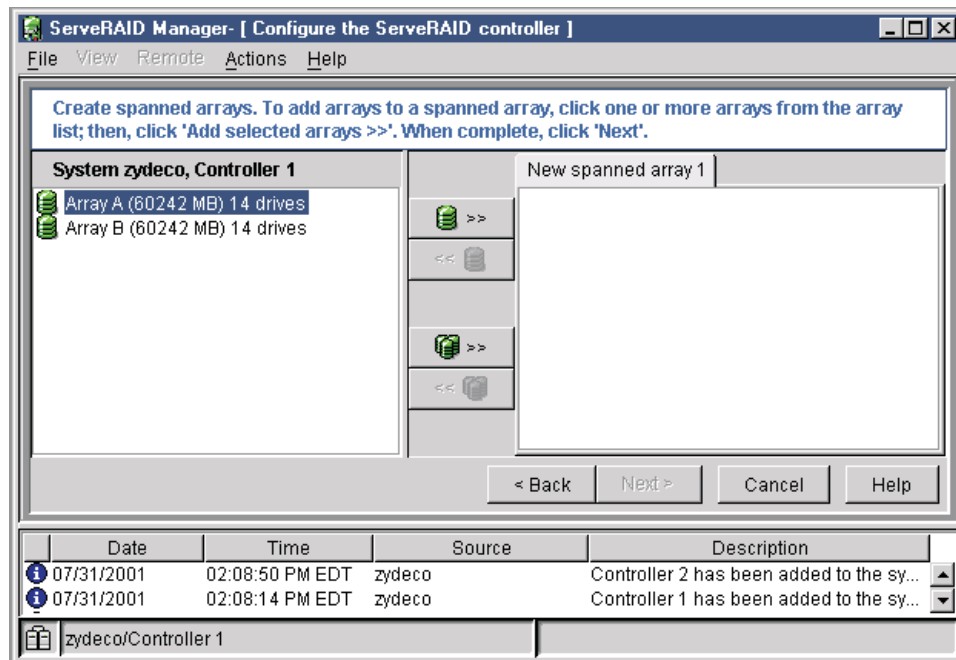




Figure 27. “Create spanned arrays” window

3. Create spanned arrays by doing the following:
 - a. In the list of arrays, click the arrays that you want to add to your spanned array.
 - b. Click  (Add selected arrays) to add the arrays to the spanned array.
You can click  (Add all arrays) to move *all* arrays to the spanned array.
 - c. To create additional spanned arrays, click the **New spanned array** tab in the right pane; then, repeat steps 3a and 3b.
4. Click **Next**; the “Create logical drives” window opens. Continue with step 9 of “Configuring ServeRAID arrays and logical drives” on page 55.

Installing the device driver

Complete the following steps to finish the active controller installation:

1. Install the fault-tolerant device driver located on the *IBM ServeRAID Failover Support for Windows NT and Windows 2000* diskette. This can be done either during or after installing Windows 2000 or Windows NT 4.0. For instructions, see the *IBM ServeRAID Device Driver Installation Instructions* on the *IBM ServeRAID Support CD*.
2. Shut down the server.

Preparing the passive controller

This section covers the following steps:

- Step 1. Installing the ServeRAID controller that you will designate as the passive controller.
- Step 2. Configuring the passive controller for failover.
- Step 3. Connecting the passive controller to the enclosure; then, starting the server.
- Step 4. Installing the appropriate device driver.

Installing the passive controller

Install the ServeRAID controller that you will designate as the passive controller. For instructions, see the *IBM Installation Guide* that came with the controller.

Configuring the passive controller

Complete the following steps to configure the passive controller for failover:

1. Start the server.

Note: The cables to the drive enclosures *must not* be attached to the passive controller when you start the server.

2. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive. The ServeRAID Manager program starts.
3. If the ServeRAID Manager program starts the Configuration wizard, a window similar to the following opens. Click **Cancel** to exit the Configuration wizard; then, in the confirmation window, click **Yes**.

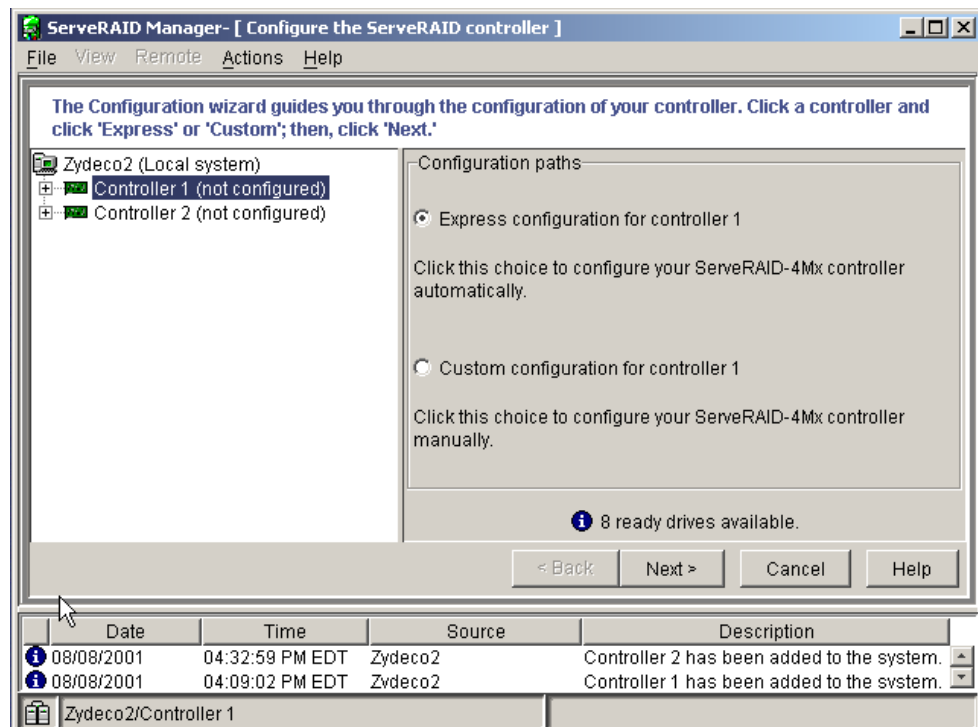



Figure 28. Configuration wizard

- In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure as the passive controller.
- Click  (Configure for clustering) on the toolbar. The “Configure controller 2 for clustering” window opens.

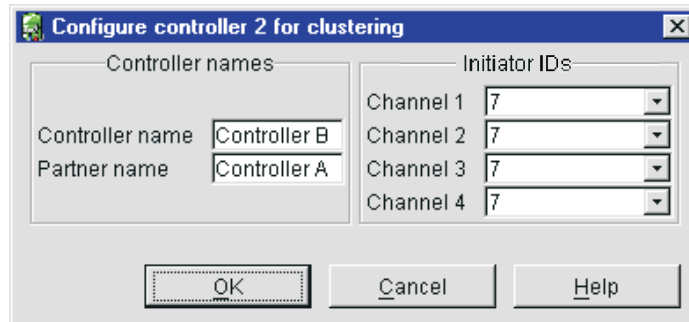


Figure 29. “Configure controller 2 for clustering” window

- Provide the following information:

Controller name

Type the name of the passive controller. This will be the same name as you typed in step 9 on page 54, for example, Controller B.

Partner name

Type name of the active controller. This will be the same name as you typed in step 9 on page 54, for example, Controller A.

Initiator IDs

The system presets these SCSI initiator IDs to 7. When configuring the passive controller, do *not* change these values. (The ServeRAID Manager program does not permit you to select numbers other than 6 and 7.)

Notes:

- The controller name and partner name are case sensitive.
 - If your configuration will contain multiple ServeRAID controller pairs, each controller name must be unique.
- Click **OK**.
 - Shut down the server.

Connecting the passive controller to the enclosure

Complete the following steps to connect the passive controller to the enclosure:

- Connect the enclosure to the passive ServeRAID controller.

Notes:

- Both the active and passive controller *must* be connected to the same enclosure.
 - The enclosure bus cables *must* be connected to the same channel on each controller. For example, the enclosure bus #1 cable is connected to Channel 1 on the active controller, and the enclosure bus #2 cable is connected to Channel 1 on the passive controller
- Restart the server.

Installing the device driver

Complete the following steps to finish the passive controller installation:

1. Install the fault-tolerant device driver located on the *IBM ServeRAID Failover Support for Windows NT and Windows 2000* diskette. This can be done either during or after installing Windows 2000 or Windows NT 4.0. For instructions, see the *IBM ServeRAID Device Driver Installation Instructions* on the *IBM ServeRAID Support CD*.
2. Shut down the server.

Completing the failover environment installation

To verify that the configuration is correct, install and start the ServeRAID Manager program on the Windows 2000 or Windows NT 4.0 server. For more information, see Chapter 10, “Installing and starting the ServeRAID Manager program” on page 93. If your failover pair is correctly configured, the ServeRAID Manager tree will designate the controllers as active and passive, as shown in the following figure.

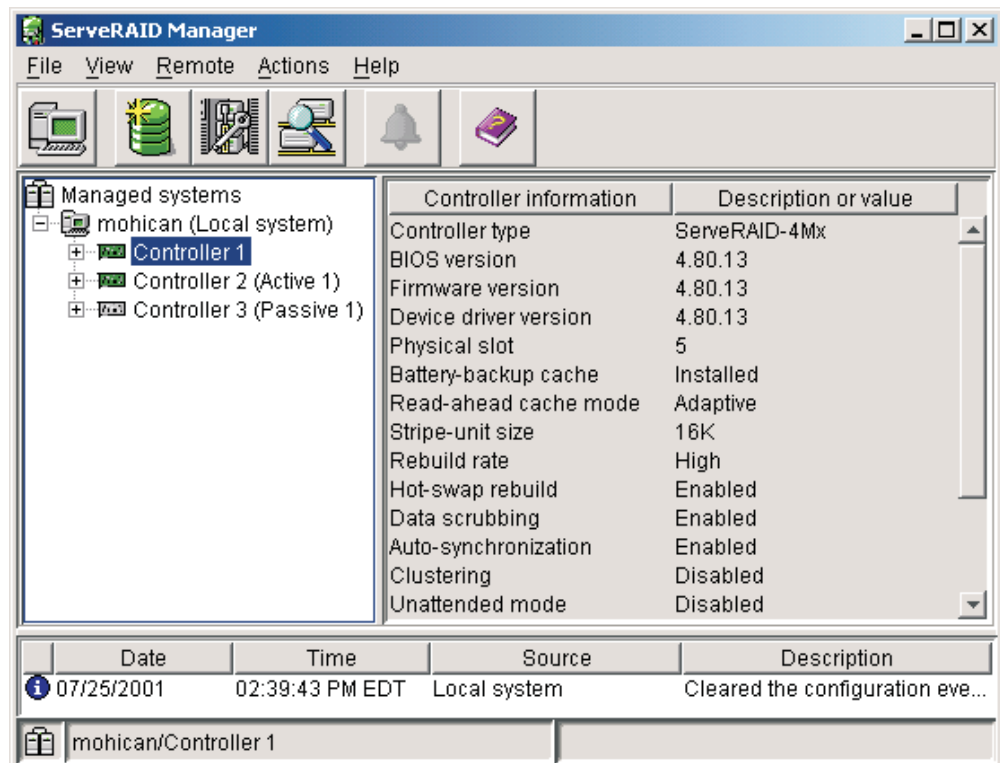


Figure 30. ServeRAID Manager window showing a correctly-configured failover pair

For troubleshooting in a failover environment, see “Solving problems in a failover environment” on page 164.

Part 2. Utility programs

Chapter 7. Using the ServeRAID Mini-Configuration program

This chapter provides the information needed to start and use the ServeRAID Mini-Configuration program.

The ServeRAID Mini-Configuration program provides a quick way to display the current settings for a ServeRAID controller. You also can use this program to perform a limited set of the configuration functions without using the *IBM ServeRAID Support CD*.

Accessing the Mini-Configuration program

Complete the following steps to access the Mini-Configuration program:

1. Turn on the server. If the server already is running, shut down the operating system; then, restart the server.
2. When the following message appears, promptly press Ctrl+I:
Press Ctrl+I to access the Mini-Configuration Program
3. If your server contains more than one ServeRAID controller, a selection screen appears. To continue, do the following:
 - a. Use the Up Arrow (↑) or Down Arrow (↓) key to select a controller.
 - b. Press Enter.

If your server contains only one ServeRAID controller, or after you select a ServeRAID controller, the main menu appears.

The following choices are available from the main menu:

- **View Controller Status** shows the current status of the ServeRAID controller. (See “Viewing the controller status” for more information.)
 - **View Configuration** shows the current configuration information for the ServeRAID controller. (See “Viewing the configuration” on page 68 for more information.)
 - **Advanced Functions** is used to restore the controller to the factory-default settings, import configuration from drives, configure BIOS settings, and view the controller and PCI information. (See “Using the advanced configuration functions” on page 68 for more information.)
4. Use the Up Arrow (↑) or Down Arrow (↓) key to highlight your choice; then, press Enter.
 5. Follow the instructions that appear on the screen.
 6. Click **Exit**. If your server contains more than one ServeRAID controller, the controller selection screen appears. Otherwise, the Mini-Configuration program closes.

Viewing the controller status

When you select **View Controller Status** from the main menu, the following information appears on the screen:

- All physical drives and their states
- **Unattend** shows the current state of the unattended mode.
 - When this option is set to **Off** and a startup error occurs, the system stops at the recovery option screen and waits for you to choose the recovery method.

- When this option is set to **On** and a startup error occurs, the system stops at the recovery option screen and waits 30 seconds for you to respond. Then, the BIOS automatically selects an appropriate option and continues the system startup process.
- **ReadAhead** shows the current state of the read-ahead cache mode.
- **CompMode** shows the current state of BIOS-compatibility mapping. **Off** indicates 8 GB (Extended); **On** indicates 2 GB (Limited).
- **Clustered** shows the current state for clustering.
- **BBC** shows the cache size of the battery-backup cache, if it is installed (8 = 8 MB or 32 = 32 MB) or **No** if there is no battery-backup cache installed.
- **Boot Blk** shows the version number of the startable microcode (or firmware) loaded for the ServeRAID controller.
- **Code Blk** shows the current version number of the microcode (or firmware) loaded for the ServeRAID controller.
- **Rebuild Rate** shows the current speed setting for rebuilds: High, Medium, or Low.
- **Number of Defunct drives** shows the current number of defunct physical drives.
- **Number of Offline drives** shows the current number of offline logical drives.
- **Number of Critical drives** shows the current number of critical logical drives.
- **Config Updates** shows the number of times that the configuration has been changed since it was initialized. When you initialize the configuration, the Config Updates resets to 0.
- **Bad Stripe, Locked Stripe, or Blocked Drive** identifies the logical drives that are affected.
 - **Bad Stripe Drives** indicates logical drives that have inaccessible areas.
 - **Locked Stripe Drives** is a reserved field.
 - **Blocked Drives** indicates the logical drives that are blocked. You must unblock a blocked drive before you can use it. See “Logical-drive-state descriptions” on page 32 for more information.

Viewing the configuration

You can select **View Configuration** from the main menu to display the number, size, RAID level, state, stripe-unit size, write-cache mode, read-ahead cache mode, and creation date for each logical drive.

Using the advanced configuration functions

You can select the **Advanced Functions** to restore the controller configuration to factory-default settings, copy the configuration to the controller from the connected physical drives, configure BIOS settings, and view the controller and PCI information.

When you select the **Advanced Functions** from the main menu, the following choices are displayed.

Attention: Be careful when making selections from this menu. If you change the configuration, you might lose data.

- **Restore to Factory Default Settings** restores all parameters in the configuration to the factory-default settings. When you reset the configuration, any data or programs stored on the logical drives attached to the selected ServeRAID controller will become inaccessible.

This choice deletes the existing configuration information; that is, it deletes all logical drives defined for the controller and sets all functional physical drives attached to the controller to the ready state.

- **Copy the Configuration from Drives to Controller** reads the most common configuration from the drives in the server and copies it to the ServeRAID controller.
- **Configure BIOS Settings** is used to modify the following BIOS settings for the ServeRAID controller:
 - BIOS support for startable CDROM
 - BIOS support for INT13 extensions
 - BIOS support for reading partition tables
 - Bypass read/verify operations
 - BIOS compatibility mapping
 - Override temporary write through
 - Load ServeRAID BIOS default settings
 - Save configuration to the ServeRAID controller
- **View Controller and PCI Information** shows the ServeRAID controller hardware and PCI register information.
- **Exit** is used to exit from the current menu to the previous menu.

Chapter 8. Installing and using the IPSSSEND command-line program

This chapter provides the information needed to install, start, and use the IPSSSEND command-line program.

IPSSSEND is an advanced command-line program that you can use to configure and manage your ServeRAID controllers. This utility program is provided on the *IBM ServeRAID Support* diskettes and the *IBM ServeRAID Support CD*.

Installing the IPSSSEND command-line program

You can use the IPSSSEND program with the following operating systems:

- Microsoft XP Professional (ServeRAID-4Lx controller only)
- Microsoft Windows 2000 Advanced Server, Datacenter, and Server
- Microsoft Windows 2000 Professional (ServeRAID-4Lx controller only)
- Microsoft Windows NT 4.0 Enterprise Edition and Server
- Novell NetWare (versions 5.x and 6.0)
- IBM OS/2 WARP Server for e-business
- Red Hat Linux (versions 6.2, 7.0, 7.1, 7.2, and 7.3)
- SuSE Linux (versions 7.1, 7.2, and 7.3)
- Caldera OpenLinux (versions 3.1 and 3.1.1)
- Turbolinux (versions 6.5 and 7.0)
- SCO OpenServer 5.0.6a
- Caldera UnixWare 7.1.1
- Caldera Open UNIX 8.0

Note: To run IPSSSEND on DOS, you must start IPSSSEND from the *IBM ServeRAID Support from DOS* diskette. This diskette contains the ASPI device driver.

Installing IPSSSEND for Windows or OS/2

You can install this program for Windows or OS/2 using either the *IBM ServeRAID Support CD* or the appropriate *IBM ServeRAID Support* diskette.

Installing IPSSSEND for Windows or OS/2 from CD

Complete the following steps to install IPSSSEND for Windows or OS/2 using the *IBM ServeRAID Support CD*:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support CD* into the CD-ROM drive. If the CD starts automatically, exit the installation program.
3. Create an IPSADM directory on your hard disk. From the operating-system command prompt, type the following and press Enter:

```
md c:\ipsadm
```

where *c* is the drive letter of the drive where the operating system is installed.

4. Copy IPSSSEND to your hard disk. Type one of the following and press Enter:

For Windows XP Professional	<code>copy e:\winpro\cmdline\ipssend.exe c:\ipsadm</code>
For Windows 2000 Server	<code>copy e:\winsrv\cmdline\ipssend.exe c:\ipsadm</code>
For Windows 2000 Professional	<code>copy e:\winpro\cmdline\ipssend.exe c:\ipsadm</code>
For Windows NT 4.0	<code>copy e:\winnt\cmdline\ipssend.exe c:\ipsadm</code>
For OS/2	<code>copy e:\os2\cmdline\ipssend.exe c:\ipsadm</code>

where *e* is the drive letter of the CD-ROM drive that contains the *IBM ServeRAID Support* CD and *c* is the drive letter of the drive where the operating system is installed.

5. Remove the CD from the CD-ROM drive.

Installing IPSSSEND for Windows or OS/2 from diskette

Complete the following steps to install IPSSSEND for Windows or OS/2 using the *IBM ServeRAID Support* diskette:

1. Start the server.
2. After the operating system starts, insert the appropriate *IBM ServeRAID Support* diskette into the diskette drive.
3. Create an IPSADM directory on your hard disk. From the operating-system command prompt, type the following and press Enter:

```
md c:\ipsadm
```

where *c* is the drive letter of the drive where the operating system is installed.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
copy a:\cmdline\ipssend.exe c:\ipsadm
```

where *a* is the drive letter of the diskette drive that contains the appropriate *IBM ServeRAID Support* diskette, and *c* is the drive letter of the drive where the operating system is installed.

5. Remove the *IBM ServeRAID Support* diskette from the diskette drive.

Installing IPSSSEND for NetWare

You can install this program for NetWare using either the *IBM ServeRAID Support* CD or the *IBM ServeRAID Support for NetWare* diskette.

Installing IPSSSEND for NetWare from CD

Complete the following steps to install IPSSSEND for NetWare using the *IBM ServeRAID Support* CD:

1. Start the server.
2. Exit to DOS. From the console prompt, type the following and press Enter:
down
3. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.

4. Copy IPSSSEND to your hard disk. From the DOS prompt, type the following and press Enter:

```
copy e:\netware\cmdline\ipssend.nlm c:\nwserver
```

where *e* is the drive letter of the CD-ROM drive that contains the *IBM ServeRAID Support CD*, *c* is the drive letter of the drive where NetWare is installed, and *nwserver* is the directory where NetWare is installed.

5. Remove the *IBM ServeRAID Support CD* from the CD-ROM drive.
6. From the DOS prompt, ensure that you are in the *c:\nwserver* directory; then, type the following and press Enter to restart NetWare:

```
server
```

Installing IPSSSEND for NetWare from diskette

Complete the following steps to install IPSSSEND for NetWare using the *IBM ServeRAID Support for NetWare diskette*:

1. Start the server.
2. Exit to DOS. From the console prompt, type the following and press Enter:
down
3. Insert the *IBM ServeRAID Support for NetWare diskette* into the diskette drive.
4. Copy IPSSSEND to your hard disk. From the DOS prompt, type the following and press Enter:

```
copy a:\cmdline\ipssend.nlm c:\nwserver
```

where *a* is the drive letter of the diskette drive that contains the *IBM ServeRAID Support for NetWare diskette*, *c* is the drive letter of the drive where NetWare is installed, and *nwserver* is the directory where NetWare is installed.

5. Remove the *IBM ServeRAID Support for NetWare diskette* from the diskette drive.
6. From the DOS prompt, ensure that you are in the *c:\nwserver* directory; then, type the following and press Enter to restart NetWare:

```
server
```

Installing IPSSSEND for Linux

You can install this program for Red Hat Linux, SuSE Linux, Caldera OpenLinux, or Turbolinux using either the *IBM ServeRAID Support CD* or the appropriate *IBM ServeRAID Support diskette*.

Note: For IPSSSEND to work properly under Linux, the following conditions must apply:

- You must have SCSI Generic support compiled into your kernel. See the Linux Kernel-HOWTO for more information on configuring and recompiling your kernel.
- You must have permission to access the SCSI Generic device files in */dev*.

Installing IPSSSEND for Linux from CD

Complete the following steps to install IPSSSEND for Linux using the *IBM ServeRAID Support CD*:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support CD* into the CD-ROM drive.

3. If your CD-ROM drive automounts, go to step 4. Otherwise, mount the CD-ROM drive. From the console, type the following and press Enter:

```
mount -r -t iso9660 /dev/cdromdevicefile /mountpoint
```

where *cdromdevicefile* is the specific device file for the CD-ROM block device, and *mountpoint* is the specific mount point of the Linux system.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mountpoint/linux/cmdline/ipssend /usr/bin
```

where *mountpoint* is the specific mount point of the Linux system.

5. Change the access permissions. Type the following and press Enter:

```
chmod 700 /usr/bin/ipssend
```

6. Unmount the CD-ROM drive. Type the following and press Enter:

```
umount /mountpoint
```

where *mountpoint* is the specific mount point of the Linux system.

7. Remove the CD from the CD-ROM drive.

Installing IPSSSEND for Linux from diskette

Complete the following steps to install IPSSSEND using the *IBM ServeRAID Support* diskette for your Linux operating system:

1. Start the server.
2. After the operating system starts, insert the appropriate *IBM ServeRAID Support* diskette into the diskette drive.
3. Mount the diskette drive. From the console, type the following and press Enter:

```
mount -t msdos /dev/diskettefile /mountpoint
```

where *diskettefile* is the specific device file for the diskette drive block device, and *mountpoint* is the specific mount point of the Linux system.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mountpoint/ipssend /usr/bin/ipssend
```

where *mountpoint* is the specific mount point of the Linux system.

5. Unmount the diskette drive. Type the following and press Enter:

```
umount /mountpoint
```

where *mountpoint* is the specific mount point of the Linux system.

6. Remove the *IBM ServeRAID Support* diskette from the diskette drive.

Installing IPSSSEND for OpenServer

You can install this program for OpenServer using either the *IBM ServeRAID Support* CD or the *IBM ServeRAID Support for SCO OpenServer* diskette.

Installing IPSSSEND for OpenServer from CD

Complete the following steps to install IPSSSEND for OpenServer using the *IBM ServeRAID Support* CD:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support* CD into the CD-ROM drive.

3. Mount the CD-ROM drive. From the console, type the following and press Enter:

```
mount -f IS09660 -o ro,lower /dev/cd0 /mnt
```

where */dev/cd0* is the specific device file for the CD-ROM block device. If you have more than one CD-ROM drive, you must replace */dev/cd0* with the specific name of the CD-ROM drive you want to use.

Note: If you currently have another device mounted on */mnt*, you must create a new directory and substitute its name for */mnt* in these instructions.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mnt/openserv/cmdline/ipssend /usr/bin
```

5. Change the access permissions. Type the following and press Enter:

```
chmod 700 /usr/bin/ipssend
```

6. Unmount the CD-ROM drive. Type the following and press Enter:

```
umount /mnt
```

7. Remove the CD from the CD-ROM drive.

Installing IPSSSEND for OpenServer from diskette

Complete the following steps to install IPSSSEND for OpenServer using the *IBM ServeRAID Support for SCO OpenServer* diskette:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support for SCO OpenServer* diskette into the diskette drive.
3. Mount the diskette drive. From the console, type the following and press Enter:

```
mount -f S51K /dev/fd0 /mnt
```

where */dev/fd0* is the specific device file for the diskette drive block device. If you have more than one diskette drive, you must replace */dev/cd0* with the specific name of the diskette drive you want to use.

Note: If you currently have another device mounted on */mnt*, you must create a new directory and substitute its name for */mnt* in these instructions.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mnt/ipssend /usr/bin/ipssend
```

5. Unmount the diskette drive. Type the following and press Enter:

```
umount /mnt
```

where */mnt* is the directory you mounted in step 3.

6. Remove the diskette from the diskette drive.
7. Change the access permissions. Type the following and press Enter:

```
chmod 700 /usr/bin/ipssend
```

Installing IPSSSEND for UnixWare or Open UNIX

You can install this program for UnixWare or Open UNIX using either the *IBM ServeRAID Support CD* or the *IBM ServeRAID Support for Caldera UnixWare and Open UNIX* diskette.

Installing IPSSSEND for UnixWare or Open UNIX from CD

Complete the following steps to install IPSSSEND for UnixWare or Open Unix using the *IBM ServeRAID Support CD*:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support CD* into the CD-ROM drive.
3. Mount the CD-ROM drive. From the console, type the following and press Enter:

```
mount -F cdfs -r /dev/cdrom/cdromdevicefile /mnt
```

where *cdromdevicefile* is the specific device file for the CD-ROM block device. Look in the */dev/cdrom* directory to determine what *cdromdevicefile* is on your server, for example, *c0b0t010*.

Note: If you currently have another device mounted on */mnt*, you must create a new directory and substitute its name for */mnt* in these instructions.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mnt/openunix/cmdline/ipssend /usr/bin
```
5. Change the access permissions. Type the following and press Enter:

```
chmod 700 /usr/bin/ipssend
```
6. Unmount the CD-ROM drive. Type the following and press Enter:

```
umount /mnt
```
7. Remove the CD from the CD-ROM drive.

Installing IPSSSEND for UnixWare or Open UNIX from diskette

Complete the following steps to install IPSSSEND for UnixWare or Open Unix using the *IBM ServeRAID Support for Caldera UnixWare and Open UNIX* diskette:

1. Start the server.
2. After the operating system starts, insert the *IBM ServeRAID Support for Caldera UnixWare and Open UNIX* diskette into the diskette drive.
3. Mount the diskette drive. From the console, type the following:

```
mount -F s5 /dev/fd0 /mnt
```

If you have more than one diskette drive, you might need to replace */dev/fd0* with the specific name of the diskette drive that you want to use.

Note: If you currently have another device mounted on */mnt*, you must create a new directory and substitute its name for */mnt* in these instructions.

4. Copy IPSSSEND to your hard disk. Type the following and press Enter:

```
cp /mnt/ipssend /usr/bin/ipssend
```
5. Type the following and press Enter:

```
rm -f /tmp/ipssend.z
```
6. Unmount the diskette drive. Type the following and press Enter:

```
umount /mnt
```

where *mnt* is the directory you mounted in step 3 on page 75.

7. Remove the diskette from the diskette drive.

8. Change the access permissions. Type the following and press Enter:

```
chmod 700 /usr/bin/ipssend
```

Starting the IPSSSEND command-line program

You can run IPSSSEND either from your operating system or by using the startable (bootable) *IBM ServeRAID Support for DOS* diskette. When you run IPSSSEND without parameters, a list of available functions and their specific parameters is displayed. For a description of the available functions and their parameters, see “Using the IPSSSEND command-line program”.

Starting IPSSSEND from Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, or Open UNIX

To start and run IPSSSEND without parameters, type one of the following and press Enter:

For Windows and OS/2	<code>c:\ipsadm\ipssend</code>
For NetWare	<code>load ipssend</code>
For Linux, OpenServer, UnixWare, and Open UNIX	<code>/usr/bin/ipssend</code>

where *c* is the drive letter of the drive where the operating system is installed.

Starting IPSSSEND from DOS

Complete the following steps to start IPSSSEND:

1. Insert the *IBM ServeRAID Support for DOS* diskette into the diskette drive.
2. Restart the server.
3. Type the following and press Enter:

```
a:\ipssend
```

where *a* is the diskette drive letter.

Using the IPSSSEND command-line program

The IPSSSEND command-line program provides a quick way to do the following:

- Create backup copies of data (see “FlashCopy function (for Windows only)” on page 78)
- Copy ServeRAID controller configurations from one server to another (see “Server roll-out functions” on page 84)
- Recover from a failed physical drive and rebuild an affected logical drive (see “Error-recovery functions” on page 85)
- Isolate problems and determine their causes (see “Problem-isolation and debug functions” on page 86)
- Create logical drives; display or modify a limited set of configuration settings (see “RAID configuration functions” on page 88)

Note: If you do not have the IPSSSEND program installed, see “Installing the IPSSSEND command-line program” on page 71.

The syntax conventions are as follows:

- Commands are shown in uppercase letters.
- Variables are shown in italics and explained immediately afterward.
- Optional commands or variables are enclosed in brackets.
- Where you must type one of several commands, the values are separated by slashes.
- Default values are underlined.
- Repeatable parameters are enclosed in braces, and the maximum number of repetitions is specified.

FlashCopy function (for Windows only)

Note: The ServeRAID-5i controller does not support the FlashCopy function.

The FlashCopy function creates a quick backup copy of data. It sets up a link between the source and target partitions; then, it creates a snapshot-like backup of the source data on the target partition. Any changes made to the source drive after you issue the command are not reflected on the target drive; the target drive is instantly available for access. You can use the backup copy of data for such tasks as tape backup, drive cloning, and multiserver rollout.

There are two primary FlashCopy functions: backup and nobackup. The FlashCopy backup function copies the entire contents of the source partitions to the target partitions so that entire logical drives can be moved from one server to another. The FlashCopy nobackup function creates a temporary snapshot copy of a partition for tape drive backup and reference purposes. The FlashCopy nobackup function is less I/O-intensive than the FlashCopy backup function.

Other FlashCopy functions include the following:

- **delete:** You can use this function to delete an array.
- **import:** After a FlashCopy backup function is completed, you can use this function to move a logical drive to another server.
- **map:** You can use this function to determine the partition numbers and whether they are available for the FlashCopy backup or nobackup processes.
- **stop all:** You can use this function to break the links between the source and target partitions.

Important

Before using FlashCopy, consider the following:

- The source and target partitions must be on the same controller.
- You can have up to four FlashCopy links active at one time.
- There is no limit on source and target partition size. However, the size of the target partition must be equal to or larger than that of the source partition. For optimal space usage, the target partition should be the same size as the source partition.
- The source and target partitions must have the same file-system type, allocation-unit size, and compression setting.
- The source and target drives must be part of the same type of array. That is, either both drives are part of a spanned array, or both drives are part of a nonspanned array.
- If the source and target drives are part of a spanned array, the following conditions must apply:
 - Each array must have the same number of sub-arrays.
 - Each logical drive on the spanned array can have only one partition.
- Normal I/O functions can be performed on the source partition while the FlashCopy operation is in progress.
- If you are performing a FlashCopy backup, do not write to the target partition until the FlashCopy backup process is complete. If you are performing a FlashCopy nobackup, do not write to the target partition *at all*.
- You can use the noprompt option to run some FlashCopy functions without receiving any interactive prompts.

The following information explains the FlashCopy functions in more detail.

Function	What it does	Command
<p>flashcopy backup</p>	<p>This function creates a snapshot of the data contained on the source partitions and writes it to the corresponding target partitions. The link between each source partition and target partition exists until all the data is copied; then, the operation is complete and the link is automatically broken. At this point, the source partitions are ready for immediate use, and each target partition contains a valid copy of the source partition data that existed at the exact time you issued the FlashCopy backup command. The physical drives containing the target partitions can be removed and used with another ServeRAID controller.</p>	<p>IPSSSEND FLASHCOPY <i>controller</i> BACKUP <i>{source target}</i> [POLL] [FORCE] [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>source</i> is the source partition number, and <i>target</i> is the target partition number. The maximum number of repetitions of <i>{source target}</i> is four. • POLL is an optional parameter that displays the progress of the backup function. • FORCE is an optional parameter that creates a FlashCopy of a source partition that is the boot partition and either contains open files or a memory paging file. <p>Note: Using the FORCE option will not guarantee file consistency between the source and target partitions.</p> <ul style="list-style-type: none"> • NOPROMPT is an optional parameter that overrides the user prompt. <p>Notes:</p> <ol style="list-style-type: none"> 1. Only one FlashCopy backup process (involving up to four source and target partitions) can be active on a controller at a time. If a FlashCopy backup process is in progress, you cannot issue another FlashCopy backup or FlashCopy nobackup command until the previous FlashCopy backup process is completed. 2. You must initiate multiple FlashCopy links at the same time. If you want to initiate four FlashCopy links, you <i>must</i> initiate the links on the same command. For example: <pre>IPSSSEND FLASHCOPY BACKUP 1 2 3 4 5 6 7 8</pre> <p>You <i>cannot</i> initiate the four links across multiple commands, such as the following: <pre>IPSSSEND FLASHCOPY BACKUP 1 2 3 4 IPSSSEND FLASHCOPY BACKUP 5 6 7 8</pre></p>
<p>flashcopy delete</p>	<p>This function deletes an array. You can use the ServeRAID Manager program to identify the array you want to delete. This program can make the LEDs flash for the physical drives that belong to the specific array.</p> <p>Note: The FlashCopy delete function is not available in a cluster configuration.</p> <p>Important: If your target logical drive is configured with write-back cache enabled, wait 10 minutes after the FlashCopy backup is completed before issuing a FlashCopy delete command. This ensures that all data has been moved from the controller cache to the logical drive.</p>	<p>IPSSSEND FLASHCOPY <i>controller</i> DELETE <i>arrayID</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>arrayID</i> is one of the following: <ul style="list-style-type: none"> – For a nonspanned array: (A–H) – For a spanned array: (1–8) • NOPROMPT is an optional parameter that overrides the user prompt.

Function	What it does	Command
flashcopy import	<p>Use this function to merge logical-drive information from physical drives when they are added to an existing server configuration.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. The stripe-unit size of the logical drives being imported must be the same as the stripe-unit size of the logical drives on the new controller. 2. The number of physical drives you add must be equal to the number of physical drives that were in the logical drive defined originally. 3. The physical drives must be added while the server is on. 4. When a logical drive is imported, all partitions from that logical drive are also imported automatically. You cannot import a single partition selectively. 5. You must manually assign drive letters after the import is completed. 6. The FlashCopy import function is not available in a cluster configuration. 	<p>IPSSSEND FLASHCOPY <i>controller</i> IMPORT ALL/<i>n</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • ALL specifies that all logical drives are to be imported • <i>n</i> is the logical drive number (1–8) for the specific drive you want to import

Function	What it does	Command
flashcopy map	<p>This function lists the following information for each operating-system partition:</p> <ul style="list-style-type: none"> • Partition number, letter, and size • Logical drive number • Array letter • Whether the partition is available for FlashCopy <p>Run the FlashCopy map command before starting a FlashCopy backup or FlashCopy nobackup procedure.</p>	<p>IPSSSEND FLASHCOPY <i>controller</i> MAP</p> <p>where <i>controller</i> is the ServeRAID controller number (1–12).</p> <p>If a partition is <i>not</i> available for FlashCopy, the report contains one of the following explanatory notes:</p> <p>Note 1 This is either an active FlashCopy link or unavailable due to active FlashCopy links. See the table below for details. Use the stop function to break these links. After the link is broken, you can reissue the FlashCopy backup or FlashCopy nobackup functions.</p> <p>Note 2 One or more of the following is true for this partition:</p> <ul style="list-style-type: none"> • The partition is the boot partition. • The partition does not have an NTFS or FAT file system. • The partition does not have a drive letter assigned. • There is more than one partition defined on this logical drive in the spanned array. • The partition has open files. • The partition has a memory-paging file. <p>You can override these requirements by using the force option. See the FlashCopy backup and FlashCopy nobackup functions for more details.</p> <p>Note 3 One or more of the following is true for this partition:</p> <ul style="list-style-type: none"> • The partition is in the blocked state. • The partition is not in the okay or critical state. • The partition is currently synchronizing, rebuilding, or migrating. <p>Note 4 FlashCopy can support up to four active links only.</p> <p>Note 5 There is no partition defined on this logical drive.</p>

Function	What it does	Command
flashcopy nobackup	<p>This function creates a snapshot of the data contained on the source partitions; however, it does not back up the entire contents of the source partitions to the target partitions. The snapshot exists only while there is a link between the source and target partitions. The link between the source and target partitions exists until you issue the FlashCopy stop all command. After you issue the FlashCopy stop all command, the target partition is no longer accessible. Compared to the FlashCopy backup command, the FlashCopy nobackup command requires less internal ServeRAID processing and disk accesses; it has a smaller impact on performance.</p>	<p>IPSSSEND FLASHCOPY <i>controller</i> NOBACKUP {<i>source target</i>} [FORCE] [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>source</i> is the source partition number, and <i>target</i> is the target partition number. The maximum number of repetitions of {<i>source target</i>} is four. FORCE is an optional parameter that creates a FlashCopy of a source partition that is the boot partition and either contains open files or a memory paging file. <p>Note: Using the FORCE option will not guarantee file consistency between the source and target partitions.</p> <ul style="list-style-type: none"> NOPROMPT is an optional parameter that overrides the user prompt. <p>Notes:</p> <ol style="list-style-type: none"> Only one FlashCopy nobackup link (involving up to four source and target partitions) can exist on a ServeRAID controller. If a FlashCopy nobackup function is invoked, you cannot issue another FlashCopy nobackup or FlashCopy backup command until existing nobackup links are broken. You must initiate multiple FlashCopy links at the same time. For example, if you want to initiate four FlashCopy links, you <i>must</i> initiate the links on the same command: <pre>IPSSSEND FLASHCOPY NOBACKUP 1 2 3 4 5 6 7 8</pre> <p>You <i>cannot</i> initiate the four links across multiple commands, such as the following:</p> <pre>IPSSSEND FLASHCOPY NOBACKUP 1 2 3 4 IPSSSEND FLASHCOPY NOBACKUP 5 6 7 8</pre>
flashcopy stop all	<p>This function breaks all open links between the source and target partitions. After you issue the FlashCopy stop all command, the target partition contents are no longer accessible and you must reformat your target partitions. This includes stopping in the <i>middle</i> of a FlashCopy backup operation. Data is valid during the FlashCopy backup and after the FlashCopy backup is completed, but not after a FlashCopy stop is issued during a FlashCopy backup procedure.</p> <p>Note: After a FlashCopy stopall command is executed, the ServeRAID Manager program will display an event indicating that the FlashCopy has failed. This is normal.</p>	<p>IPSSSEND FLASHCOPY <i>controller</i> STOPALL [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) NOPROMPT is an optional parameter that overrides the user-prompt.

Server roll-out functions

The following table describes the IPSSSEND server roll-out functions.

Function	What it does	Command and supported operating systems
autosync	<p>This function synchronizes a new logical drive. This computes and writes the parity data, verifying that the data redundancy for the logical drive is correct. Because this function runs in the background, you can use the logical drive immediately.</p> <p>Note: Use this function only on RAID level-5 logical drives.</p>	<p>IPSSSEND AUTOSYC <i>controller logicaldrive</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>logicaldrive</i> is the logical drive number (1–8) NOPROMPT is an optional parameter that overrides the user prompt <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
backup	<p>This function saves information concerning a controller configuration to a diskette or to a physical drive. The information includes the following:</p> <ul style="list-style-type: none"> BIOS settings Array and logical drive definitions Cluster parameters <p>Note: The ServeRAID controller configuration must be valid.</p>	<p>IPSSSEND BACKUP <i>controller filename</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>filename</i> is the path and file name where the configuration is to be written NOPROMPT is an optional parameter that overrides the user prompt <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
copyld	<p>This function copies the content of one logical drive (the source) to another logical drive (the target).</p> <p>Note: The size of the target logical drive must be greater than or equal to the size of the source logical drive.</p>	<p>IPSSSEND COPYLD <i>controller source target</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>source</i> is the source logical drive number <i>target</i> is the target logical drive number NOPROMPT is an optional parameter that overrides the user prompt <p>Supported operating system: DOS</p>
init	<p>This function initializes the first 0.5 MB of a logical drive. This process erases the partition tables; you will lose access to data on the logical drive.</p> <p>Note: (Linux only) Restart your server to clear the previous partition tables from memory.</p>	<p>IPSSSEND INIT <i>controller logicaldrive</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>logicaldrive</i> is the logical drive number (1–8) NOPROMPT is an optional parameter that overrides the user prompt <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
restore	<p>This function loads a configuration from a file stored on a diskette or on a hard disk. This operation overwrites the existing configuration information and BIOS settings stored on a ServeRAID controller.</p> <p>Note: The configuration must be a valid configuration file created using the IPSSSEND backup function.</p>	<p>IPSSSEND RESTORE <i>controller filename</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>filename</i> is the path and file name where the configuration is to be written NOPROMPT is an optional parameter that overrides the user prompt <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Function	What it does	Command and supported operating systems
synch	This function synchronizes the parity information on redundant logical drives. If the parity information is inconsistent, IPSSSEND repairs it automatically.	<p>IPSSSEND SYNCH <i>controller</i> DRIVE/GROUP <i>scopeid</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • DRIVE is a single logical drive • GROUP is a merge group • <i>scopeid</i> is one of the following: <ul style="list-style-type: none"> – If DRIVE, the logical drive number (1–8) – If GROUP, the merge-group number <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Error-recovery functions

The following table describes the IPSSSEND error-recovery functions.

Function	What it does	Command and supported operating systems
getstatus	This function displays information about the most recent rebuild, synchronization, logical drive migration, or FlashCopy. The information includes the type of operation, status, logical drive number, logical drive size, and percentage of the operation completed.	<p>IPSSSEND GETSTATUS <i>controller</i></p> <p>where <i>controller</i> is the ServeRAID controller number (1–12).</p> <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
rebuild	This function rebuilds a defunct physical drive. You can use this function for arrays that contain one or more logical drives in the critical state.	<p>IPSSSEND REBUILD <i>controller dch dsid nch nsid</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>dch</i> is the channel number for the defunct drive (1–4) • <i>dsid</i> is the SCSI ID for the defunct drive (0–15) • <i>nch</i> is the channel number for the new drive (1–4) • <i>nsid</i> is the SCSI ID for the new drive (0–15) <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Function	What it does	Command and supported operating systems
setstate	<p>This function changes the state of a physical drive.</p> <p>Attention: Be very careful when using this function. For example, you might lose data if you change a physical drive from the defunct to online state without first performing a rebuild operation.</p>	<p>IPSSSEND SETSTATE <i>controller channel sid newstate</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>channel</i> is the channel number for the drive (1–4) • <i>sid</i> is the SCSI ID for the drive (0–15) • <i>newstate</i> is the new state for the drive. Valid states are: <ul style="list-style-type: none"> – EMP for Empty – RDY for Ready – HSP for Hot spare – SHS for Standby hot spare – DDD for Defunct disk drive – DHS for Defunct hot spare – RBL for Rebuild – SBY for Standby – ONL for Online <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
unlock	<p>This function provides access to a blocked RAID level-0 logical drive.</p> <p>Important: The logical drive might contain damaged data. You must recreate or restore the data.</p>	<p>IPSSSEND UNBLOCK <i>controller logicaldrive</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>logicaldrive</i> is the logical drive number (1–8) <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Problem-isolation and debug functions

The following table describes the IPSSSEND problem-isolation and debug functions.

Function	What it does	Command and supported operating systems
certify	<p>This function verifies the media of a physical drive. If IPSSSEND finds errors, it reassigns the sectors. Once the procedure is complete, IPSSSEND summarizes the reassignments and Predictive Failure Analysis® (PFA) errors.</p>	<p>IPSSSEND CERTIFY <i>controller channel sid</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>channel</i> is the channel number for the device (1–4) • <i>sid</i> is the SCSI ID for the device (0–15) <p>Supported operating system: DOS</p>
eraseevent	<p>This function clears all entries in the designated event logs. (See <code>getevent</code> for descriptions of the ServeRAID controller device event, soft event, and hard event logs).</p>	<p>IPSSSEND ERASEEVENT <i>controller</i> DEVICE/SOFT/HARD/ALL</p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • DEVICE is the device event log • SOFT is the ServeRAID controller soft event log • HARD is the ServeRAID controller hard event log • ALL is the ServeRAID controller device event, soft event, and hard event logs <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Function	What it does	Command and supported operating systems
format	<p>This function performs a low-level format of a physical drive, erasing all data.</p> <p>Attention: After issuing the format command, do not stop the formatting process. If you stop the process, the physical drive will not respond to anything except the format function. To recover the drive, see “Recovering from an incomplete format of a physical drive” on page 156.</p>	<p>IPSSSEND FORMAT <i>controller channel sid</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • <i>channel</i> is the channel number for the device (1– 4) • <i>sid</i> is the SCSI ID for the device (0–15) <p>Supported operating system: DOS</p>
getevent	<p>This function displays the contents of the designated event logs.</p>	<p>IPSSSEND GETEVENT <i>controller</i> DEVICE/SOFT/HARD/ALL</p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • DEVICE is the device event log • SOFT is the ServeRAID controller soft event log • HARD is the ServeRAID controller hard event log • ALL is the ServeRAID controller device event, soft event, and hard event logs <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
getversion	<p>This function lists the versions of BIOS, cluster DLL, device driver, and firmware for every ServeRAID controller in the server.</p>	<p>IPSSSEND GETVERSION</p> <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
identify	<p>This function flashes the LEDs on a designated physical or logical drive. To stop the LEDs from flashing, press any key.</p>	<p>IPSSSEND IDENTIFY <i>controller</i> PHYSICALDRIVE/LOGICALDRIVE <i>options</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • PHYSICALDRIVE is the designated physical drive • LOGICALDRIVE is the designated logical drive • <i>options</i> is one of the following: <ul style="list-style-type: none"> – If PHYSICAL DRIVE, the channel ID and SCSI ID – If LOGICALDRIVE, the logical drive number (1-8) <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
selftest	<p>This function directs a controller or physical drive to perform its self-test. You must restart the server after the self-test is completed.</p>	<p>IPSSSEND SELFTEST <i>controller options</i> AD/PD <i>channel sid</i></p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • AD is the ServeRAID controller self-test • PD is the physical drive self-test • (If PD) <i>channel</i> is the drive channel (1–4), and <i>sid</i> is the SCSI ID for the device (0–15). <p>Supported operating system: DOS</p>

RAID configuration functions

The following table describes the IPSSSEND RAID configuration functions.

Function	What it does	Command and supported operating systems
create	<p>This function create logical drives on either an existing or a new array. To define a new array, you must type the channel and SCSI ID of the physical drives.</p> <p>Note: You cannot create RAID level-x0 logical drives with this function.</p> <p>After the logical drive is created, a quick initialization is done. The quick initialization process initializes the first 1024 sectors of the logical drive.</p> <p>If you assign the logical drive RAID level-5 or RAID level-5E and the ServeRAID controller supports auto-synchronization, the logical drive automatically synchronizes in the background. If the controller does not support the auto-synchronization feature, you can use the IPSSSEND synch function to synchronize the RAID level-5 or RAID level-5E logical drives. After synchronization, the logical drives are available for storing data.</p>	<p>IPSSSEND CREATE <i>controller</i> LOGICALDRIVE NEWARRAY/ARRAYID <i>size raidlevel {channel sid}</i> [NOPROMPT]</p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) NEWARRAY indicates that you are creating a new array and logical drive ARRAYID is the Array ID (A–H) of the existing array on which you want to create a logical drive <i>size</i> is one of the following: <ul style="list-style-type: none"> The size in MB of the logical drive MAX indicates that you want to use all available space in the array. <i>raidlevel</i> is the RAID level for the logical drive (0, 1, 1E, 5, or 5E) If NEWARRAY, <i>channel</i> is the channel number for the device (1– 4), and <i>sid</i> is the SCSI ID for the device (0–15). The maximum number of repetitions of <i>{channel sid}</i> is 16. NOPROMPT is an optional parameter that overrides the user prompt. <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
delete	<p>This function deletes an array. You will lose all the data contained in logical drives defined in the array.</p> <p>Note: You cannot delete spanned arrays (RAID level-x0 logical drives) with this function.</p>	<p>IPSSSEND DELETE <i>controller</i> ARRAY <i>arrayID</i></p> <p>where</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>arrayID</i> is the array identifier (A-H) of an existing array <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
devinfo	<p>This function lists the state and size of a physical drive.</p>	<p>IPSSSEND DEVINFO <i>controller channel sid</i></p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>channel</i> is the channel number for the device (1– 4) <i>sid</i> is the SCSI ID for the device (0–15) <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>
drivever	<p>This function lists the vendor ID, firmware version, and serial number of a designated physical drive. IPSSSEND retrieves this information directly from the physical drive.</p>	<p>IPSSSEND DRIVEVER <i>controller channel sid</i></p> <p>where:</p> <ul style="list-style-type: none"> <i>controller</i> is the ServeRAID controller number (1–12) <i>channel</i> is the channel number for the device (1– 4) <i>sid</i> is the SCSI ID for the device (0–15) <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Function	What it does	Command and supported operating systems
getconfig	This function lists information about a controller, logical drive, or physical drive. This information potentially includes (but is not limited to) the following: <ul style="list-style-type: none"> • Controller type • BIOS, boot block, device driver, and firmware versions • Logical drive status, RAID level, and size • Physical drive type, SCSI ID, presence of PFA • Physical drive state 	IPSSSEND GETCONFIG <i>controller</i> AD/LD/PD/AL where: <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • AD specifies the controller information. • LD specifies the logical drive information. • PD specifies the physical device information. • AL specifies all information. Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS
hsrebuild	This function enables the hot-swap rebuild feature.	IPSSSEND HSREBUILD <i>controller</i> ON where <i>controller</i> is the ServeRAID controller number (1–12) Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS
readahead	This function enables, disables, or sets the read-ahead cache mode to “Adaptive.”	IPSSSEND READAHEAD <i>controller</i> ON/OFF/ADAPTIVE where: <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • ON enables the read-ahead cache mode • OFF disables the read-ahead cache mode • ADAPTIVE indicates that the controller will determine the best mode to use at any given time. Supported operating system: DOS
scandrives	This function scans all SCSI channel on a controller for the following: <ul style="list-style-type: none"> • Physical drives that have been added • Ready drives that have been removed 	IPSSSEND SCANDRIVES <i>controller</i> where <i>controller</i> is the ServeRAID controller number (1–12) Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS
setconfig	This function modifies the controller configuration. You can either restore the controller to the factory-default settings, or you can copy the configuration from physical drives attached to a controller.	IPSSSEND SETCONFIG <i>controller</i> DEFAULT/IMPORTDRIVE [NOPROMPT] where: <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • DEFAULT restores the controller to the factory-default settings. All logical drives that are currently defined will be deleted. • IMPORTDRIVE copies the configuration from the drives attached to the controller. To import from a specific physical drive, type the channel number and the SCSI ID; otherwise, the controller selects the drive from which to import the configuration. This option is useful when you are replacing a controller and reestablishing the original configuration on the new controller. • NOPROMPT is an optional parameter that overrides the user prompt. Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS

Function	What it does	Command and supported operating systems
unattended	This function enables or disables unattended mode. This controller setting determines how the BIOS handles failures during system startup.	<p>IPSSSEND UNATTENDED <i>controller</i> ON/OFF</p> <p>where:</p> <ul style="list-style-type: none"> • <i>controller</i> is the ServeRAID controller number (1–12) • ON enables the feature • OFF disables the feature <p>Supported operating systems: Windows, NetWare, OS/2, Linux, OpenServer, UnixWare, Open UNIX, and DOS</p>

Chapter 9. Using the IPSMON command-line program (NetWare only)

This chapter provides the information about installing, starting, and using the IPSMON command-line program.

You can use the IPSMON program to monitor a ServeRAID controller for defunct drives, Predictive Failure Analysis (PFA) warnings, rebuild operations, FlashCopy operations, synchronizations, logical-drive migrations, and RAID level-5E compressions. Whenever activities occur, this program can log a message to the screen, to a file, or to both the screen and a file.

You can use the IPSMON program with Novell NetWare 5.x only.

This utility program is provided on the *IBM ServeRAID Support for Novell NetWare* diskette.

Installing the IPSMON command-line program

You can install this program for NetWare using the *IBM ServeRAID Support for Novell NetWare* diskette. Complete the following steps to install the IPSMON program for NetWare:

1. Start the server.
2. From the console prompt, type the following and press Enter:
down
3. Insert *IBM ServeRAID Support for Novell NetWare* diskette into the diskette drive.
4. From the DOS prompt, type the following and press Enter:
copy a:\ipsmon.nlm c:\nwserver

where *a* is the diskette drive letter and *c:\nwserver* is where NetWare is installed.

5. Remove the diskette from the diskette drive.
6. At the DOS prompt, ensure that you are in the *c:\nwserver* directory; then, type the following and press Enter to restart NetWare:
server

Using the IPSMON command-line program

Complete the following steps to run the IPSMON program:

1. From the console, type the following:
load ipsmon
2. Press Enter.

When you start IPSMON, it immediately begins polling all ServeRAID controllers for specific conditions. If a condition is found, this program logs a message to the screen, to a file, or to both the screen and a file.

Note: IPSMON continuously polls the ServeRAID controllers until you type unload ipsmon at the system console.

Command: **ipsmmon options**

where *options* is one of the following optional parameters:

- -F:*filename* to specify the name of the file in which to record messages. The default file name is IPSMON.LOG.
- -S to display messages on the standard output (usually the screen).
- -? to obtain a current list of valid parameters.

Note: If you start this program without any command-line parameters, the IPSMON program will log the messages to the IPSMON.LOG file, and the messages will not be displayed on the screen.

During operation, IPSMON logs various messages. Each message contains an alert code and a location specifier.

- The alert code begins with the message type and number:
 - **INF** (information) followed by the message number
 - **WRN** (warning) followed by the message number
 - **CRT** (critical) followed by the message number
- The location specifier comes after the alert code:
 - **A** followed by the controller number
 - **C** followed by the channel number (if required)
 - **SID** followed by the SCSI ID (if required)

For example, a message of CRTxxx:A2C3SID04 signifies that a Critical condition (CRTxxx) was found on Controller 2 (A2), Channel 3 (C3), SCSI ID 4 (SID04).

The IPSMON program can log the following messages, based on the condition being monitored and errors detected.

Information Messages:

```
<Date and Time> INF000:A1C-SID-- (no errors detected)
<Date and Time> INF001:A1C-SID-- (rebuild started)
<Date and Time> INF002:A1C-SID-- (rebuild completed)
<Date and Time> INF003:A1C-SID-- (synchronization started)
<Date and Time> INF004:A1C-SID-- (synchronization completed)
<Date and Time> INF005:A1C-SID-- (migration started)
<Date and Time> INF006:A1C-SID-- (migration completed)
```

Warning Messages:

```
<Date and Time> WRN001:A2C3SID12 (PFA error detected)
```

Critical Messages:

```
<Date and Time> CRT001:A3C2SID04 (dead drive detected)
<Date and Time> CRT002:A1C-SID-- (controller is not responding to
commands)
```

Chapter 10. Installing and starting the ServeRAID Manager program

After installing the operating system and device drivers on your server, you can install the ServeRAID Manager program. The ServeRAID Manager program provides a graphical interface that you can use while your server is running. You can use the interface to do the following:

- Monitor ServeRAID configuration changes
- Perform configuration functions, including create an array, delete an array, create a logical drive, change the RAID level, dynamically increase the logical drive size, rebuild an array, configure ServeRAID controllers for failover, and configure a cluster

Note: ServeRAID Manager does not support all of these functions for the integrated RAID controller that is a standard feature in some IBM xSeries servers.

For information about using the ServeRAID Manager program, see the ServeRAID Manager online help or Chapter 4, “Configuring ServeRAID controllers” on page 35.

Installing the ServeRAID Manager program

This section provides instructions for installing the ServeRAID Manager program.

When using:	Go to:
Windows XP	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
Windows 2000	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
Windows NT 4.0	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
Windows Me	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
Windows 98	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
Windows 95	“Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95” on page 94.
NetWare	“Installing ServeRAID Manager on NetWare” on page 94.
Linux	“Installing ServeRAID Manager on Red Hat Linux, SuSE Linux, Caldera OpenLinux, or Turbolinux” on page 95.
OS/2	“Installing ServeRAID Manager on OS/2” on page 95.
OpenServer	“Installing ServeRAID Manager on OpenServer” on page 96.
UnixWare	“Installing ServeRAID Manager on UnixWare or Open UNIX” on page 97.
Open UNIX	“Installing ServeRAID Manager on UnixWare or Open UNIX” on page 97.

If you are installing ServeRAID Manager on an IBM xSeries server that contains an integrated RAID controller, see the documentation provided with your server for a list of supported operating systems.

Installing ServeRAID Manager on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95

Notes:

1. When installed on Windows XP Professional, Windows 2000, or Windows NT 4.0, this version of the ServeRAID Manager program supports up to 12 ServeRAID controllers.
2. When installed on Windows Millennium Edition (Me), Windows 98, and Windows 95, the ServeRAID Manager program works *only* as a console. You can use the console to connect to remote servers that contain ServeRAID controllers. Servers installed with Windows Me, Windows 98, or Windows 95 as the operating system *do not* support ServeRAID controllers.

Complete the following steps to install the ServeRAID Manager program on Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. When the installation program starts, follow the instructions on the screen to install the program.

Note: If you are installing ServeRAID Manager on an IBM server that supports Active PCI under Windows NT 4.0, select the IBM ServeRAID Hot Replace Wizard to enable the hot-replace feature. This feature also requires that you install the DMI Service provider and the IBM Hot Plug for Windows NT 4.0 Package, version 4.2 or later. For more information, see “Using a ServeRAID controller in a server with Active PCI features” on page 11.

Installing ServeRAID Manager on NetWare

Note: The NetWare version of the ServeRAID Manager program supports up to eight ServeRAID controllers.

Important

Before you install the ServeRAID Manager program, complete the following tasks:

- Install the latest Support Pack before installing the Novell Java™ Virtual Machine (JVM) for NetWare. You can download the latest Support Pack from the Novell Web site at <http://support.novell.com/misc/patlst.htm#nw/>.
- Check that your Novell JVM is version 1.2.2 or later. Versions older than 1.2.2 are not compatible with the ServeRAID Manager program. To check your JVM version, load Java and type at the NetWare command prompt:

```
JAVA -VERSION
```

You can download the latest JVM from the Novell Web site at <http://www.novell.com/download/>.

Complete the following steps to install the ServeRAID Manager program on Novell NetWare:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. From the command-line prompt, type the following and press Enter:

```
load cdrom
```

3. From the command-line prompt, type the following and press Enter:

```
serveraid:\netware\manager\install
```

The installation program starts.
4. Follow the instructions on the screen to install ServeRAID Manager.

Installing ServeRAID Manager on Red Hat Linux, SuSE Linux, Caldera OpenLinux, or Turbolinux

Notes:

1. The ServeRAID Manager program comes with the IBM Java Runtime Environment (JRE).
2. If the ServeRAID Manager program has previously been installed on your server, you must remove that version before upgrading. All customization files (such as Managed system tree nodes and the Notification list) are saved and used in the upgrade. To remove the ServeRAID Manager program from Linux, type the following command:

```
rpm --erase RaidMan
```
3. When installed on Linux, this version of the ServeRAID Manager program supports up to eight ServeRAID controllers.

Complete the following steps to install the ServeRAID Manager program on Red Hat Linux, SuSE Linux, Caldera Open Linux, or Turbolinux:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. If your CD-ROM drive automounts, type the following command and go to step 6. Otherwise, go to step 3.

```
rpm --install /mnt/cdrom/linux/manager/RaidMan-5.10.i386.rpm
```

3. If your CD-ROM drive does *not* automount, type the following and press Enter:

```
mount -r -t iso9660 /dev/cdromdevicefile /mountpoint
```

where *cdromdevicefile* is the specific device file for the CD-ROM block device, and *mountpoint* is the mountpoint of the Linux system.

4. Type the following and press Enter:

```
rpm --install /mountpoint/cdrom/linux/manager/RaidMan-4.80.i386.rpm
```

where *mountpoint* is the mountpoint of the device file used in step 3.

5. When the installation is complete, type the following:

```
umount /mountpoint
```

where *mountpoint* is the mountpoint of the Linux system.

6. Press Enter. You can now remove the CD from the CD-ROM drive.

Installing ServeRAID Manager on OS/2

Note: When installed on OS/2, this version of the ServeRAID Manager program supports up to eight ServeRAID controllers.

Complete the following steps to install the ServeRAID Manager program on OS/2:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Open an OS/2 command window.

3. Type the following and press Enter:
`e:`

 where *e* is the CD-ROM drive letter.
4. Type the following and press Enter:
`cd \os2\manager`
5. Type the following and press Enter:
`install`
6. The installation program starts. Follow the instructions on the screen. On the final installation panel, specify the location where you want to install the ServeRAID Manager program.

Installing ServeRAID Manager on OpenServer

Notes:

1. When installed on OpenServer, this version of the ServeRAID Manager program supports up to eight ServeRAID controllers.
2. To install or remove the ServeRAID Manager package, you *must* have root privileges.
3. If ServeRAID Manager is installed on your system, you must remove the old version before upgrading. All customization files (such as Managed system tree nodes and the Notification list) are saved and used in the upgrade. To remove the ServeRAID Manager program from OpenServer, type the following command:

```
pkgrm RaidMan
```

Complete the following steps to install the ServeRAID Manager program on OpenServer:

Note: The ServeRAID Manager program requires that you install either the Java Development Kit (JDK) for SCO operating systems, versions 1.1.7b or 1.1.3u, or the Java Runtime Environment (JRE) for SCO operating systems, version 1.1.8. You can download the JDK and JRE from the Caldera Web site at <http://www.caldera.com/download/>.

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Type the following and press Enter:
`mount -r -f HS,lower /dev/cd0 /mnt`
3. Type the following and press Enter:
`cd /mnt/openserv/manager`
4. Type the following and press Enter:
`./mgr_inst`
5. When the installation is complete, type the following and press Enter:
`cd /`
6. Type the following and press Enter:
`umount /mnt`

You can now remove the CD from the CD-ROM drive.

Installing ServeRAID Manager on UnixWare or Open UNIX

Notes:

1. The ServeRAID Manager program requires that you install either the JDK for SCO operating systems, versions 1.1.7b or 1.1.3u, or the JRE for Caldera UNIX operating systems, version 1.3.0. You can download the JDK and JRE from the Caldera Web site at <http://www.caldera.com/download/>.
2. To install or remove the ServeRAID Manager package, you *must* have root privileges.
3. If the ServeRAID Manager program has previously been installed on your server, you must remove that version before upgrading. All customization files (such as Managed system tree nodes and the Notification list) are saved and used in the upgrade. To remove the ServeRAID Manager program from UnixWare or Open UNIX, type the following command:

```
pkgrm RaidMan
```
4. When installed on UnixWare or Open UNIX, the current version of the ServeRAID Manager program supports up to eight ServeRAID controllers.

Complete the following steps to install the ServeRAID Manager program for UnixWare or Open UNIX:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Type the following and press Enter:

```
mount -r -F cdfs /dev/cdrom/cdromdevicefile /mnt
```

where *cdromdevicefile* is the specific device file for the CD-ROM block device. Look in the */dev/cdrom* directory to determine what *cdromdevicefile* is on your server, for example, *c0b0t010*.

3. Type the following and press Enter:

```
cd /mnt/openunix/manager
```
4. Type the following and press Enter:

```
./mgr_inst
```
5. When the installation is complete, type the following and press Enter:

```
cd /
```
6. Type the following and press Enter:

```
umount /mnt
```

You can now remove the CD from the CD-ROM drive.

Starting the ServeRAID Manager program

After you have configured your ServeRAID controller, installed the device drivers, installed the operating system, and installed the ServeRAID Manager program on your server, you can administer and monitor your ServeRAID controllers, as well as modify the ServeRAID controller configuration.

Starting the ServeRAID Manager program in Windows XP, Windows 2000, Windows NT 4.0, Windows Me, Windows 98, or Windows 95

To start the ServeRAID Manager program in Windows 2000, Windows NT, Windows Me, Windows 98, or Windows 95, click **Start** → **Programs** → **ServeRAID Manager** → **ServeRAID Manager**. The ServeRAID Manager program opens, and a window similar to the following appears.

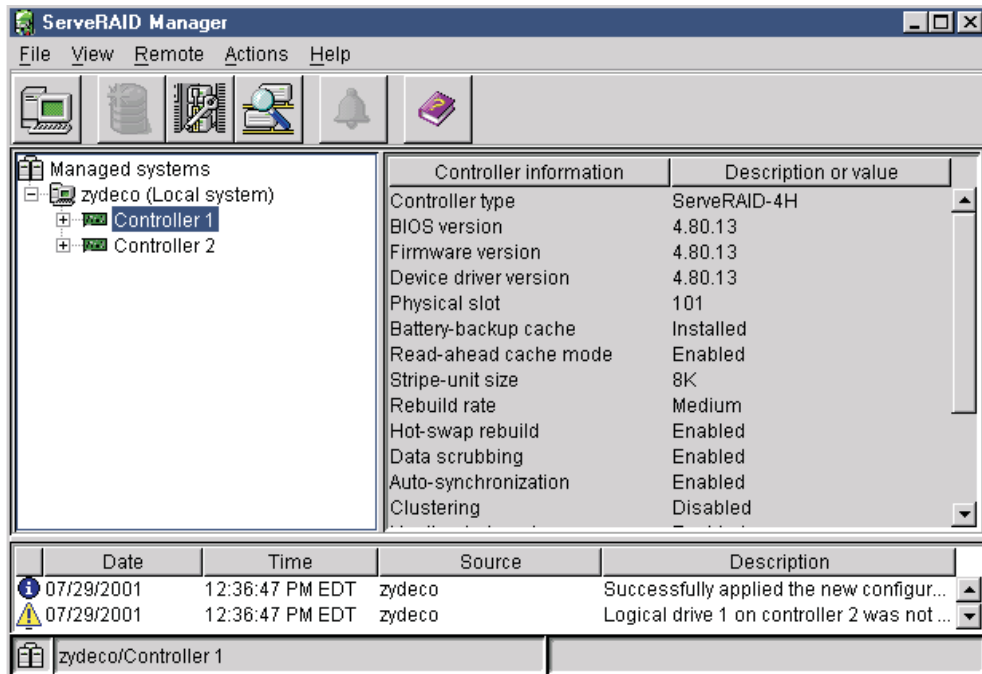


Figure 31. ServeRAID Manager window

Starting the ServeRAID Manager program in NetWare

To start the ServeRAID Manager program in NetWare:

1. From the NetWare console, type the following and press Enter:
LOAD RAIDMAN
2. The ServeRAID Manager program opens, and a window similar to that shown in Figure 31 appears.

Starting the ServeRAID Manager program in OS/2

To start the ServeRAID Manager program from the OS/2 desktop, double-click the **ServeRAID Manager** icon.

Complete the following steps to start the ServeRAID Manager program from an OS/2 command line:

1. Change to the directory where you installed the ServeRAID Manager program. Type the following and press Enter:
cd \RaidMan
2. Press Enter.
3. Type the following and press Enter:
RaidMan

The ServeRAID Manager program opens, and a window similar to that shown in Figure 31 appears.

Starting the ServeRAID Manager program in OpenServer, UnixWare, Open UNIX, and Linux

Complete the following steps to start the ServeRAID Manager program in OpenServer, UnixWare, Open UNIX, or Linux:

Note: Ensure that you have superuser privileges before starting these procedures.

1. To change to the directory where you installed the ServeRAID Manager program, type one of the following:

For OpenServer	<code>cd /opt/RaidMan</code>
For UnixWare and Open UNIX	<code>cd /opt/RaidMan</code>
For Linux	<code>cd /usr/RaidMan</code>

2. Press Enter.
3. Type the following and press Enter:
`sh RaidMan.sh`
4. The ServeRAID Manager program opens, and a window similar to that shown in Figure 31 appears.

Note: (UnixWare and Open UNIX only) When installed on UnixWare or Open UNIX, the ServeRAID Manager program might list the installed ServeRAID controllers in a different order than the ServeRAID Manager program in startable-CD mode. To identify a specific controller, refer to its physical slot number.

Part 3. Installing the IBM ServeRAID Cluster Solution

Chapter 11. Introduction to the IBM ServeRAID Cluster Solution

A *cluster* is a group of independent computer systems that work together as a single logical system. A client interacts with a cluster as though it is a single server. In other words, a cluster is a group of computers linked together in such a way that they share and manage a set of resources that can support a number of users at the same time.

This *high-availability clustering solution* is based on a two-server cluster, where both servers can access the same storage devices, but only one server at a time controls the storage devices shared by both servers. If one of the two running servers fails, the remaining server automatically assumes control of the shared resources managed by the failed server while still controlling its own resources at the same time. Then, the failed server can be repaired offline without the loss of time or work efficiency, because the shared data and applications earlier managed by the failed server are still online to the clients.

When the failed server is operational again, it can be placed back into the cluster; the resources are reallocated between the two servers and the cluster resumes normal operation.

A *controller* is a device that coordinates and controls the operation of one or more input and output devices, such as workstations, and synchronizes the operation of such devices with the operation of a system as a whole.

The IBM ServeRAID Cluster Solution, as discussed in this book, uses one of the following controllers:

- IBM ServeRAID-4H Ultra160 SCSI controller
- IBM ServeRAID-4M Ultra160 SCSI controller
- IBM ServeRAID-4Mx Ultra160 SCSI controller
- IBM ServeRAID-4L Ultra160 SCSI controller
- IBM ServeRAID-4Lx Ultra160 SCSI controller

The IBM ServeRAID Cluster Solution also uses IBM expansion enclosures, such as the following:

- IBM Netfinity EXP15 Rack Storage Enclosure
- IBM Netfinity EXP200 Rack Storage Enclosure
- IBM Netfinity EXP300 Rack Storage Enclosure

Note: You can configure only 13 physical drives in an EXP300 enclosure.

You can install the IBM ServeRAID Cluster Solution by using one of the following software applications:

- Microsoft Cluster Server, which is part of Windows NT Server Enterprise Edition
- Microsoft Cluster Server, which is part of Windows 2000 Advanced Server Edition.

The following figures show an example of a simple high-availability clustering solution. The first figure shows a high-level view of a cluster; the second figure shows a more detailed view of a cluster.

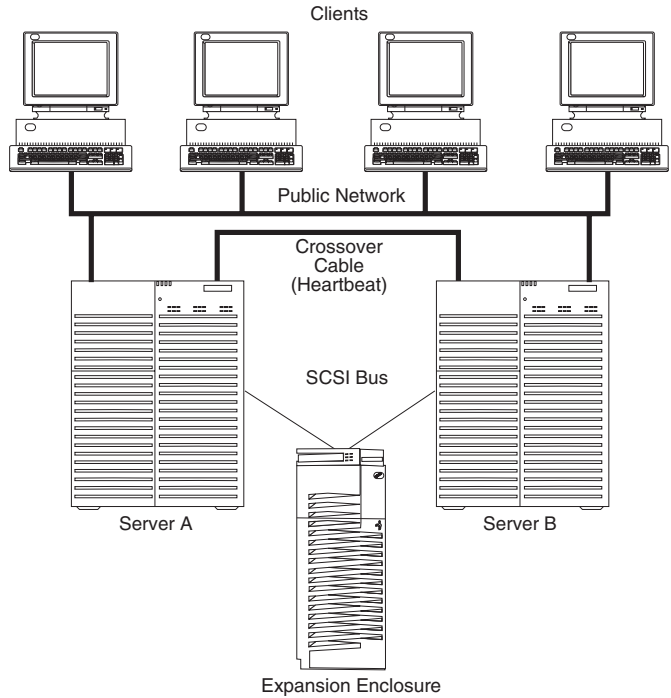


Figure 32. A high-level view of a cluster

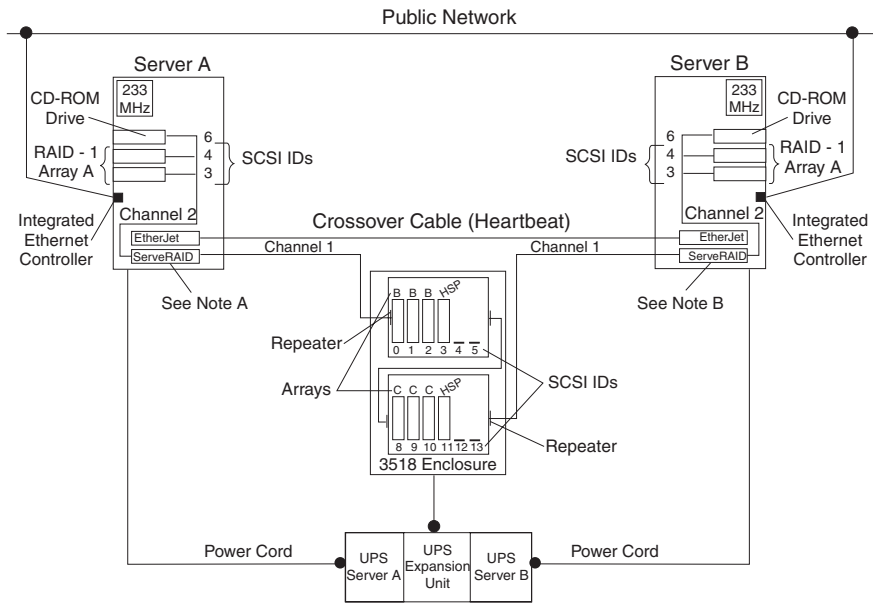


Figure 33. A detailed view of a cluster

Note A: Server A

- Shared Channel 1 - SCSI ID 6
- Non-shared Channel 2 - SCSI ID 7

Note B: Server B

- Shared Channel 1 - SCSI ID 7
- Non-shared Channel 2 - SCSI ID 7

The solution you use for your installation depends on your specific requirements. For more information about requirements and types of installations, see the *IBM Shared Disk Clustering Hardware Reference*. You can obtain this publication from the IBM Support Web site. See Chapter 16, “Obtaining ServeRAID updates” on page 141 for additional information.

Chapter 12. Preparing to install or change a cluster solution

Note: If you are going to upgrade an existing high-availability cluster solution and are already familiar with the concepts of a cluster, go to “Updating the ServeRAID BIOS, firmware, and software code for clustering” on page 141. If you are setting up a high-availability cluster solution for the first time, continue reading this section.

Before you begin installing and setting up a high-availability cluster solution, familiarize yourself with the following terms and definitions, as well as some considerations concerning the ServeRAID controller.

Terms and definitions

The following terms are used in this section. For a detailed explanation of these terms, see the Server Cluster Glossary in the Windows Platform Software Developers Kit.

Failover is the process of relocating the cluster resources from a failed server to the remaining server. The resource-monitor program responsible for the resource detects the failure. If a resource failure occurs, the resource-monitor program notifies the Cluster Service, which triggers the actions that are defined in the failover policy for that resource. A failover can occur automatically, such as when an application or a server fails, or it can occur manually, such as when a system administrator moves all applications onto one server and then shuts down the other server for scheduled maintenance. Failover generally includes three tasks:

- Failure detection
- Resource relocation
- Application restart

Failback is a special case of failover. It is the process of moving back some or all groups of resources to the preferred owner after a failover has occurred. The *preferred owner* is the server in the cluster on which you prefer each group of resources to run. If the preferred owner fails, its resources are transferred to the other server. When the preferred owner is repaired and comes back online and **allow failback** is enabled in the Microsoft Cluster Administration program, the resources are automatically transferred back to that server.

Resource Group is a set of dependent resources that you can group together. Some cluster resources cannot go online unless other cluster services are running. These services are *resource dependencies*. When one resource is listed as a dependency for another resource, the two resources must be placed in the same group. If all resources are ultimately dependent on one resource (for example, one physical disk resource), all resources must be in the same group. Therefore, all resources in a cluster might need to be in the same group.

Furthermore, any cluster operation performed on a group is performed on all resources that are in that group. For example, if a resource must be moved from Server A to Server B, all resources that are in the same group as the resource will be moved also.

ServeRAID considerations

It is important to understand the following ServeRAID considerations before you set up your high-availability cluster solution.

Hardware considerations

- You must cable the SCSI channels in a controller pair so that the controllers share the same channels.
- You must connect all disks that will be shared to the shared channels. This includes hot-spare drives, as well as data drives.
- Each shared physical drive must be part of a logical drive or defined as a hot spare to one or the other servers. You must remove all other physical drives from the shared disk enclosure to ensure proper operation.
- Do not connect nondisk devices, such as CD-ROM or tape drives, to shared channels. These devices will be accessible to both servers, and conflicts might arise.

Controller considerations

- *Controller pair* is a term that refers to two controllers, one in each system, that are connected to each other through the same SCSI bus.
- Each ServeRAID controller must have a different SCSI initiator ID assigned to the shared channels. For example, set one server, Server A, to ID 6, and set the other server, Server B, to ID 7. The setup instructions describe this in more detail.
- You must set the stripe-unit size of each ServeRAID controller in a pair to the same value (8 KB, 16 KB, 32 KB, or 64 KB).
- Each ServeRAID controller must have a unique controller name assigned.
- Do not change the controller name on both ServeRAID controllers in a pair at the same time. Doing so can cause problems and might require that you restart the server.
- You *cannot* share hot-spare drives between controllers in a cluster pairing. If you want hot-spare protection, *each* ServeRAID controller must have a hot-spare drive defined. You *must* connect hot-spare drives *only* to shared channels. Both servers must be able to access their uniquely-defined hot-spare drives in case a failover occurs *after* a hot-spare drive replaces a failed shared drive.
- Physical drives that are configured by one controller in the pair must appear as ready drives to the other controller in the pair. Be sure to verify this criterion when you add drives. Restart both servers, or scan for new devices using the ServeRAID Manager program on both servers, to make sure the added physical drives appear as ready drives on both servers before creating logical drives.

Array or logical drive considerations

- Create only *one* logical drive for each array.
- Every logical drive that is shared by the two servers *must* have its write-cache mode set to write through; this will help ensure that data integrity is maintained. For logical drives that are not shared between the two servers, set the write-cache mode to write back; this will improve performance.
- You must assign merge-group numbers in the range 1–8 to each logical drive that will be shared. Merge-group numbers must be unique for each shared logical drive in the cluster. You must assign merge-group numbers 206 or 207 to the non-shared logical drives.

- If you are starting (booting) the operating system from a shared controller, define the first logical drive as the startup drive and assign a merge-group number for a non-shared drive, for example, 206 for Server A.
- The total number of logical drives per controller must be eight or less before or after a failover. If you exceed this number, a failover will not be completed.
- The following logical drives will not failover:
 - Logical drives currently undergoing Logical Drive Migration (LDM) operations
 - RAID level-5E logical drives undergoing compression or decompression
 - RAID level-5 or level-5E logical drives in a critical state

However, all other logical drives will failover if necessary.

- The ServeRAID controller does not permit the failover of RAID level-5 or level-5E logical drives that are in a critical state. For this reason, do not use RAID level-5 or level-5E for the quorum drive. You must configure the quorum drive as a RAID level-1 logical drive.

Note: Define hot-spare drives in your array to minimize the time that logical drives remain in critical state.

- If a failover occurs while a critical RAID level-1, level-1E, level-10 or level-1E0 logical drive is rebuilding to a spare disk, the rebuild operation automatically restarts.
- The cluster support software will initiate a synchronization of all RAID level logical drives except for the following:
 - RAID level-0 logical drives
 - Any critical or offline logical drives.

If a drive fails before this synchronization is complete, logical drive access is blocked and is no longer accessible.

- When a logical drive spans multiple SCSI channels and a failure within the drive subsystem occurs that is unique to a channel (for example, a disconnected cable), the entire physical array will be identified as failed even though access from the surviving server can occur. Therefore, if you have small arrays, consider not spanning multiple channels.

Chapter 13. Configuring ServeRAID controllers for clustering

Before configuring the ServeRAID controllers, you must first install the BIOS and firmware code. For more information, see “Updating the ServeRAID BIOS, firmware, and software code for clustering” on page 141.

Configuring the controller for Microsoft Cluster Server using Windows 2000 or Windows NT 4.0

If you are configuring ServeRAID controllers for Microsoft Cluster Server on Windows 2000 or Windows NT 4.0, complete the following steps:

1. If necessary, perform any operating-system shutdown procedure on *both* servers that you are going to use in the cluster.
2. Turn off *both* servers.
3. If you have not done so, connect any shared external drive enclosures to both servers; then, turn on the enclosures.
4. Follow the procedure “Configuring a controller for clustering” on page 112 for each shared controller in Server A, and then return to this step.
5. Continue with the procedure “Configuring ServeRAID arrays and a logical drive” on page 113 for Server A, and then return to this step.
6. Before you configure Server B, for complicated clusters you might want to use **View shared drives** to identify online drives in Server B as reserved.
 - a. From Server A, right-click the controller and select **View shared drives**.
 - b. Select the **Enable view shared drives** check box.
 - c. Set the channel and SCSI ID for the drives that are identified as ready on Server A and online on Server B.

Drives used in the cluster will be displayed as reserved on Server B.

7. Follow the procedure “Configuring a controller for clustering” on page 112 for each shared controller in Server B, and then return to this step.
8. Remove the *IBM ServeRAID Support CD* from the CD-ROM drive.
9. Restart Server A; then, restart Server B.
10. If you are installing the IBM ServeRAID Cluster Solution using Microsoft Cluster Server on Windows 2000, go to “Installing the Microsoft Cluster Server software on Windows 2000” on page 126.

If you are installing the IBM ServeRAID Cluster Solution using Microsoft Cluster Server on Windows NT 4.0, go to “Installing the Microsoft Cluster Server software on Windows NT 4.0” on page 119.

Note: After you have completed installing the IBM ServeRAID Cluster Solution, use the **Validate cluster** action in the ServeRAID Manager program to verify the cluster configuration. See “Validating a cluster” on page 137 for more information.

Configuring a controller for clustering

Complete the following steps to configure a controller for clustering.

Note: For complete information on using the ServeRAID Manager program, see the ServeRAID Manager online help.

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive; then, turn on the server. The ServeRAID Manager program starts.
2. If the ServeRAID Manager program detects unconfigured ServeRAID controllers and ready drives, the program automatically starts the Configuration wizard, and a window similar to the following opens. To exit the Configuration wizard, click **Cancel**; then, in the confirmation window, click **Yes**.

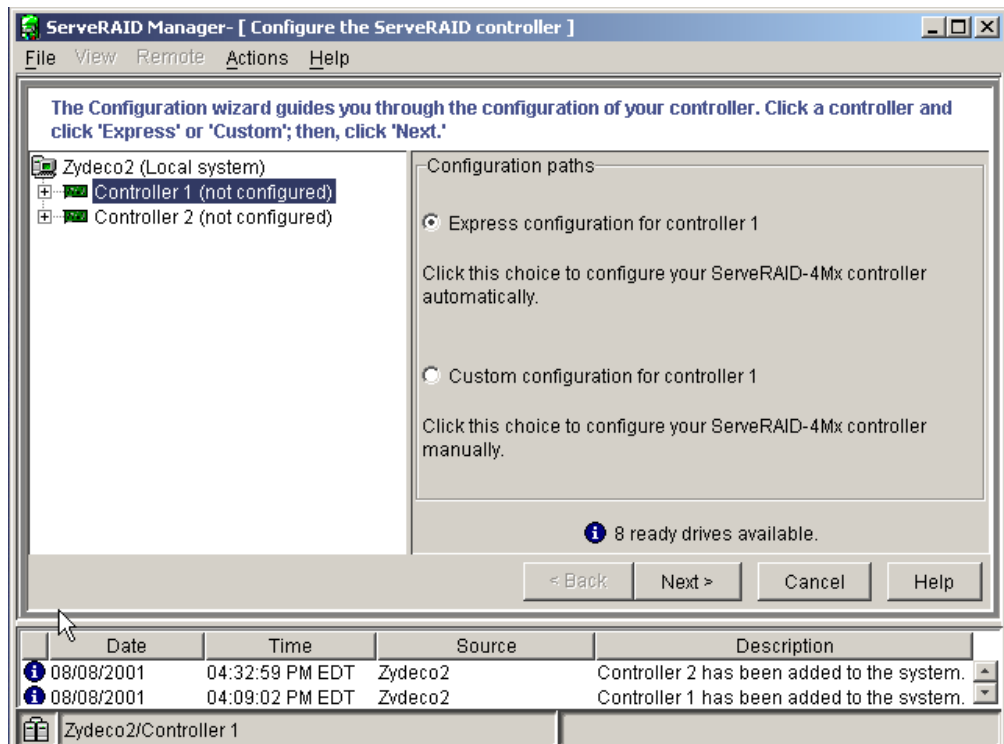


Figure 34. Configuration wizard


3. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure.

Attention

Restore the ServeRAID controller to factory-default settings only once, when the controller is first installed. This process removes all configuration information from NVRAM, including the SCSI initiator IDs, the controller and partner names, and the array information.

This point is especially important if the Windows 2000 or Windows NT 4.0 system startup drive is attached to the IBM ServeRAID controller. If this process occurs after the startup drive array has been created, the array information will be removed, and the system will no longer start in Windows 2000 or Windows NT 4.0.

If you already have logical drives defined that you want to keep, go to step 6. Steps 4 and 5 will cause loss of data by deleting all logical drives already defined.

4. Click **Actions** → **Restore to factory-default settings**.
5. If a confirmation window opens, click **Yes**. When the operation is complete, a message appears at the bottom of the window indicating that ServeRAID Manager has successfully restored the configuration to the factory-default settings.
6. In the ServeRAID Manager tree, click the ServeRAID controller that you are configuring.
7. Click  (Configure for clustering) on the toolbar. The “Configure for clustering” window opens.

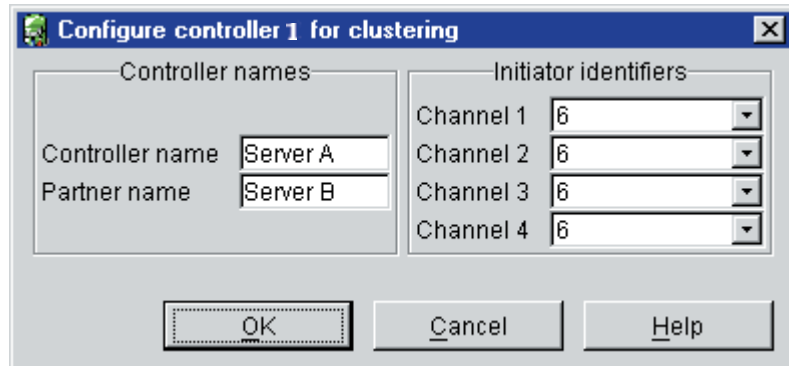


Figure 35. “Configure for clustering” window

8. Provide the following information.

Controller name

Type a name to identify the first controller, for example, Server A.

Partner name

Type a name that you will use to identify the second controller, for example, Server B.

Initiator IDs

The system presets these SCSI initiator IDs to 7. For Server A, set each ID to 6 for shared channels. For Server B, ensure that each SCSI initiator ID is set to 7 for shared channels. (The ServeRAID Manager program does not permit you to select numbers other than 6 and 7.)

Notes:


- a. The controller name and partner name are case sensitive.
 - b. If your configuration will contain multiple ServeRAID controller pairs, each controller name must be unique.
9. Click **OK**. The controller is now configured for clustering.

Configuring ServeRAID arrays and a logical drive

Important

- Define all shared logical drives on Server A.
- When defining shared logical drives, create only one logical drive for each array.
- Each controller must have its own hot-spare or standby hot-spare drive defined. This means that you must not define the same hot-spare or standby hot-spare drive on both controllers in the pair.
- Define hot-spare and standby hot-spare drives only on a shared channel.

Complete the following steps to configure arrays and logical drives:

1. Click  (Configure RAID) on the toolbar. The Configuration wizard opens.
2. In the ServeRAID Manager tree, click the ServeRAID controller that you want to configure.
3. Click **Custom configuration**.
4. Click **Next**. The “Create arrays” window opens.

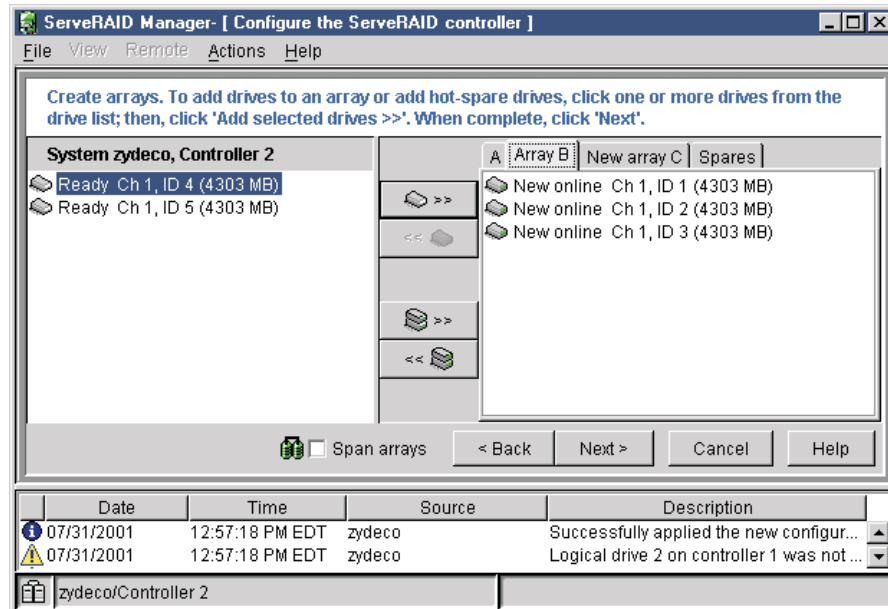




Figure 36. “Create arrays” window

5. Click the appropriate **Array** tab in the right panel; then, from the ready drives list, select the drives that you want to move to the array.

6. Click  (Add selected drives) to add the drives to an array. You can click  (Add all drives) to move *all* ready drives to an array.

Notes:

- a. Unless you define a drive as a hot-spare drive, you must use all the ready drives when creating your arrays (that is, all ready drives in the tree must be online).
 - b. Hot-spare drives are *not* shared between controllers in a cluster pairing. If you want hot-spare protection, *each* ServeRAID controller must have a hot-spare drive defined.
 - c. You *must* connect hot-spare drives *only* to shared channels. Both servers must be able to access their uniquely-defined hot-spare drives in case a failover occurs *after* a hot-spare drive replaces a failed shared drive.
 - d. You must create at least one logical drive to store the quorum resource information. This logical drive (the quorum drive) must be assigned RAID level-1.
 - e. For improved reliability, do not create arrays that span channels.
7. After you select the ready drives for your arrays, click **Next**. The “Create logical drives” window opens.

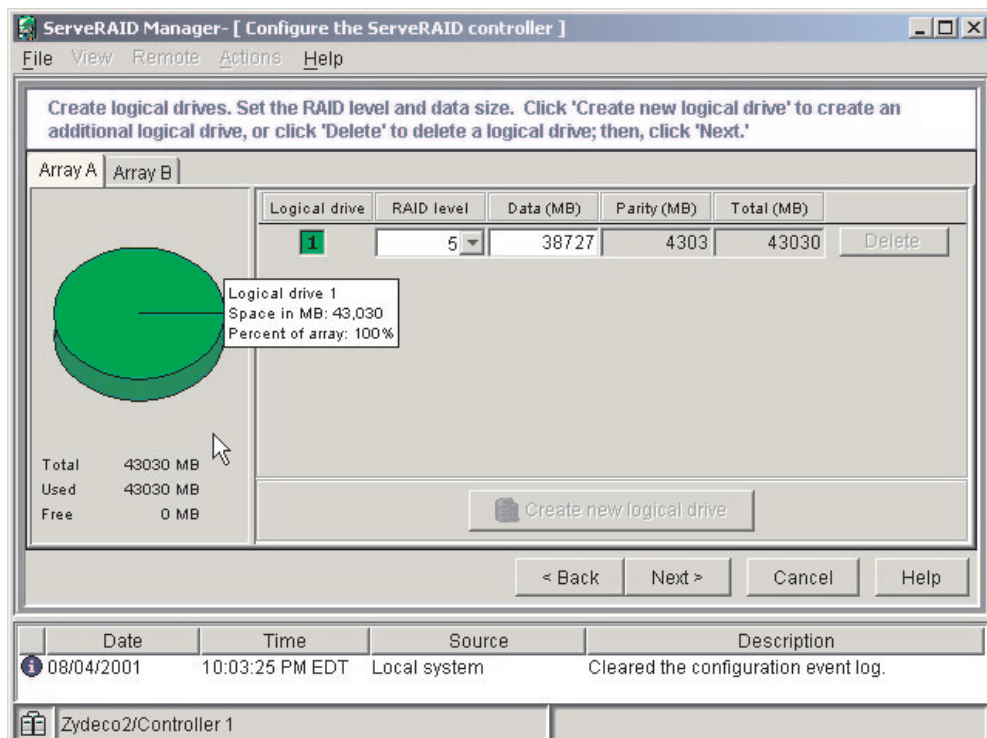


Figure 37. “Create logical drives” window

8. Click the appropriate **Array** tab.
9. Select a RAID level from the drop-down list. (For more information, see “Supported RAID levels” on page 22.)

Notes:

- a. If you have four or more ready drives in an array, the recommended RAID level is RAID level-5E.

- b. Only one logical drive can be defined for each array.
 - c. A logical drive cannot exceed 2048 GB.
10. Click **Next**. The “Configuration summary” window opens.

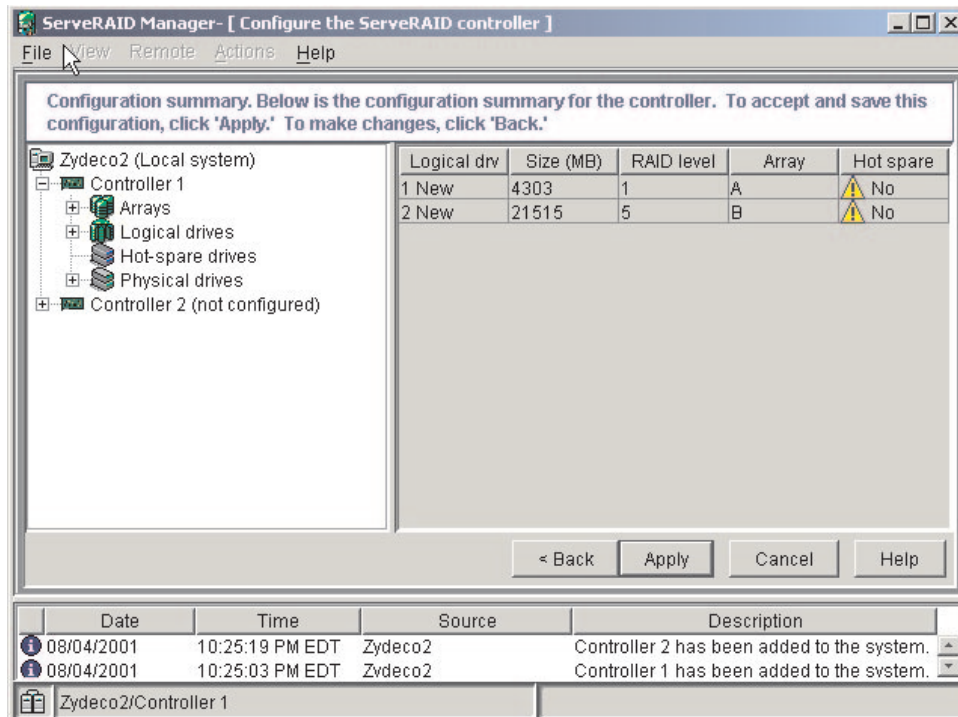


Figure 38. “Configuration summary” window


11. Review the information that is displayed in the Configuration summary window. Click **Apply**; then, click **Yes** when asked if you want to apply the new configuration. The configuration is saved in the ServeRAID controller and on the physical drives.
12. Click **Return to the ServeRAID Manager** to continue working with your ServeRAID configuration. After creating the arrays and logical drives, you must assign merge-group numbers to the shared logical drives.

Note: A merge-group number uniquely identifies each shared logical drive, even when the logical drive moves between servers.

13. In the ServeRAID Manager tree, click the ServeRAID controller that contains the logical drives.

Notes:

- a. Valid merge-group numbers for non-shared logical drives are 206 and 207. For example, set all non-shared drives on Server A to merge-group number 206 and all non-shared drives on Server B to merge-group number 207.
- b. The merge-group number must be unique for each logical drive that is shared by the controller pair. For example, if you have a logical drive with a merge-group number 1 on Server A, you cannot assign the same group number to a logical drive on Server B. Valid merge-group numbers for shared logical drives are from 1 through 8.

- Click  (Configure for clustering) on the toolbar. The “Configure for clustering” window opens.

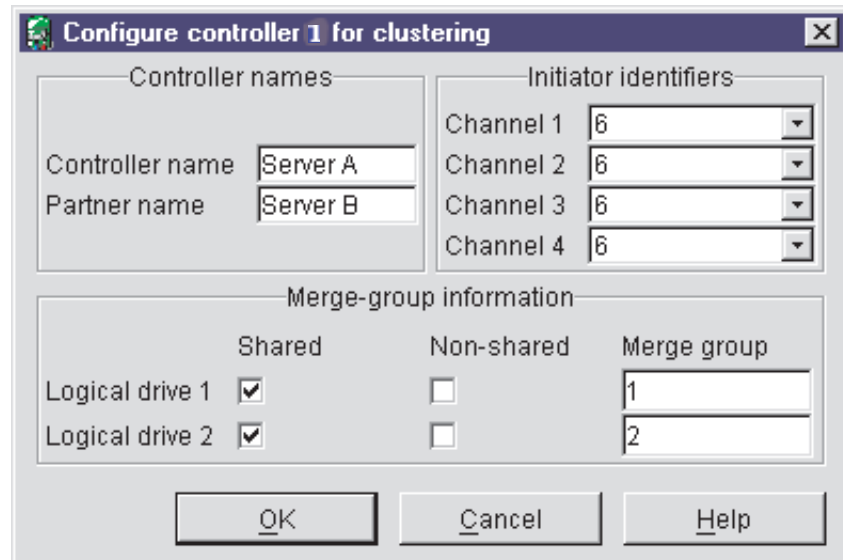


Figure 39. “Configure for clustering” window

- Select the **Shared** check boxes for all the logical drives.
- Do not change the merge-group number from the default that is provided.
- Record the controller name, partner name, and merge-group numbers, and store them in a safe place. You will need this information to recover the configuration if the ServeRAID controller fails.

Note: You can save this information to a file by using the ServeRAID Manager program:

- In the ServeRAID Manager tree, click the server.
 - Click **Actions** → **Save printable configuration**.
- Click **OK**.
 - To exit the ServeRAID Manager program, click **File** → **Exit**.
 - Click **Shutdown** or **Restart**.
 - Remove the *IBM ServeRAID Support* CD from the CD-ROM drive.
 - Continue with Chapter 14, “Installing the Microsoft Cluster Server software” on page 119.

Chapter 14. Installing the Microsoft Cluster Server software

Important

Before beginning the procedure, consider the following:

- Read “ServeRAID considerations” on page 108, which contains important information about setting up valid cluster configurations.
- Read “Configuring the controller for Microsoft Cluster Server using Windows 2000 or Windows NT 4.0” on page 111 for information on configuring Server A and Server B for the high-availability cluster solution.

After configuring the ServeRAID controller, defining logical drives, and setting up merge-group numbers, you can install Microsoft Cluster Server (MSCS) on Windows NT 4.0 or Windows 2000. Go to one of the following:

- “Installing the Microsoft Cluster Server software on Windows NT 4.0”
- “Installing the Microsoft Cluster Server software on Windows 2000” on page 126.

Installing the Microsoft Cluster Server software on Windows NT 4.0

Important

Before beginning the procedure, ensure that you are using the *IBM ServeRAID Support for Windows NT 4.0* diskette during the installation of the Microsoft Windows NT Server Enterprise Edition.

Installing the ServeRAID Manager program

Note: To run ServeRAID Manager as an installed program, you must install both the ServeRAID device driver and the appropriate device driver for your server video controller

Before installing MSCS, you must install the ServeRAID Manager program:

1. If the server is not running, turn on the server.
2. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive of Server A. The ServeRAID Manager setup program starts.
3. Click **Next**.
4. Click **Yes** to the Software License Agreement.
5. When prompted to select an operating system, select **Windows NT/Windows 2000**; then, click **Next**.
6. When prompted to install Windows NT Service, click **Yes**; then, click **Next**.
7. Select the **Destination Folder**; then, click **Next**.
8. After setup completes copying the files, click **Finish**.

Installing the Microsoft Cluster Server

Complete the following steps to install the Microsoft Cluster Server:

1. If you do not have Microsoft Windows NT Server Enterprise Edition installed already, install it with Service Pack 3 (or later) on both servers. Do not install the Microsoft Cluster Server software. When prompted, deselect the option to install MSCS; it will be installed later in this procedure.

Note: The *Microsoft Windows NT Server Enterprise Edition* CD contains Service Pack 3.

For information on installing Windows NT Server Enterprise Edition, see the documentation that is included with it. When you are finished, return to this step and continue with this procedure.

2. Use the ServeRAID Manager program to scan for new drives on both servers. Right-click on the controller, and click **Scan for new or removed ready drives**.
3. On Server A, run the utility IPSHAHTO.EXE from the *IBM ServeRAID Cluster Solution for Windows NT and Windows 2000* diskette or the *IBM ServeRAID Support* CD. At a Windows NT command line, type one of the following:

If installing from CD	<code>e:\winnt\cluster\support\ipshahto</code>
If installing from diskette	<code>a:\support\ipshahto</code>

where *a* is the diskette drive letter and *e* is the CD-ROM drive letter.

Running the IPSHAHTO program makes all the shared logical drives available for access by Server A.

4. Using the Windows NT Disk Administrator, format all shared logical drives as NTFS (NT File System), assign volume labels, and specify drive letters for each.

Important

Before creating the ServeRAID logical cluster resource, you must assign a permanent (sticky) drive letter to the shared logical drive on both servers. The two servers must have the same drive letters on each shared drive. If you do not assign permanent drive letters, Windows NT might assign different drive letters on each server. Assigning a permanent drive letter ensures that Windows NT assigns the same drive letter to the partition on both servers.

Notes:

- a. It is helpful if the volume label contains the drive letter you assigned to the drive, such as DRIVE E.
 - b. If you want to use the disk in a cluster, create only one partition on the disk. Make the partition the full size of the disk and format the partition to NTFS.
5. On Server B, run IPSHAHTO.EXE to make all shared logical drives available for access by Server B.
 6. On Server B, use the Windows NT Disk Administrator to assign the same drive letters that you assigned to each drive on Server A.

Note: Use the volume label as a guide to make sure you assign the same letters on Server B as you assigned on Server A.

7. On Server A, run IPSHAHTO.EXE again, so that Server A regains control of all shared logical drives.
8. On Server A, install the Microsoft Cluster Server (MSCS) software.

Note: The directory name and path where the MSCS software is installed must be the same on both servers.

Complete the following steps to start the installation.

Important

You must use the localquorum option when installing the Microsoft Cluster Server (MSCS) software with ServeRAID controllers.

- a. Insert the *Windows NT Server Enterprise Edition Component CD* into the CD-ROM drive on Server A.
- b. At the command line, type the following and press Enter:
`e:\MSCS\CLUSTER\I386\SETUP /localquorum`

where *e* is the CD-ROM drive letter.

Note: You *must* type the parameter `localquorum` in lowercase.

- c. Install the Microsoft Cluster Server software. Follow the instructions in the documentation included with the MSCS software.
 Server A will restart when the installation is completed.
9. On Server B, make it *join* the cluster by doing the following.

Note: The directory name and path where the MSCS software is installed must be the same on both servers.

- a. Insert the *Windows NT Server Enterprise Edition Component CD* into the CD-ROM drive on Server B. Type the following command (from either a command line or Add/Remove Programs in the Control panel) and press Enter:
`e:\MSCS\CLUSTER\I386\SETUP`

where *e* is the CD-ROM drive letter.

- b. Install the Microsoft Cluster Server software. Follow the instructions in the documentation included with the MSCS software.
 Server B will restart when the installation is completed.
10. Install the IBM ServeRAID Windows NT Cluster Solution program by doing the following:
 - a. On Server A, run the utility SETUP.EXE program from the *IBM ServeRAID Cluster Solution for Windows NT and Windows 2000* diskette or *IBM ServeRAID Support CD* and follow the instructions that appear on the screen. At a Windows NT command line, type one of the following and press Enter:

If installing from CD	<code>e:\winnt\cluster\setup</code>
If installing from diskette	<code>a:\setup</code>

where *a* is the diskette drive letter and *e* is the CD-ROM drive letter.

- b. When the setup is completed on Server A, run the utility SETUP.EXE program on Server B.

After the utility program has been installed on both servers, all shared ServeRAID groups and disk resources will be automatically created by the IBM ServeRAID Cluster Solution setup program and then brought online. Server A is the current owner of these groups.

11. Move the quorum resource from localquorum to a ServeRAID disk resource by doing the following:
 - a. On Server A, run the Microsoft Cluster Administrator program and open a connection to the cluster you just created.
 - b. Verify that the same server (for example, Server A) owns the ServeRAID disk resources and the localquorum resource and that the quorum resource is moved to a RAID level-1 logical drive.

Note: Set the quorum resources on a RAID level-1 logical drive. Do *not* set the quorum resources on a RAID level-5 or level-5E logical drive.

- c. Right-click the cluster name to open the cluster.
- d. Select **Properties**; then, click the **Quorum** tab.
- e. In the **Quorum Resource** field, select a ServeRAID shared disk.
- f. Click **OK**.
- g. Delete the Local Quorum Resource and the Local Quorum Group.

See the *Microsoft Cluster Solution Administrator's Guide* for more information.

12. Install the latest Windows NT 4.0 Service Pack on both cluster server nodes.

Note: If you installed a Windows NT 4.0 Service Pack previously, you must reinstall it now.

You now can move the shared disk resources manually using the Microsoft Cluster Administrator program or automatically during failover.

See Microsoft Knowledge Base Article Q258750, "Recommended Private 'Heartbeat' Configuration on a Cluster Server," for additional configuration information.

Creating additional ServeRAID disk resources on a Windows NT 4.0 ServeRAID cluster

You can use a ServeRAID logical disk that has not already been designated as a cluster resource, or you can create a new array and logical disk on Server A, using the ServeRAID Manager program. For more information about creating new arrays and logical drives, see Chapter 4, "Configuring ServeRAID controllers" on page 35.

Note: Be sure to assign a unique shared merge-group number to the new shared logical drive.

Important

Before creating the ServeRAID logical cluster resource, you must assign a permanent (sticky) drive letter to the shared logical drive on both servers. The two servers must have the same drive letters on each shared drive. If you do not assign permanent drive letters, Windows NT might assign different drive letters on each server. Assigning a permanent drive letter ensures that Windows NT assigns the same drive letter to the partition on both servers.

1. On Server A, do the following:
 - a. Click **Start** in the lower-left corner of the screen; then, click **Programs → Tools → Administrative Tools → Disk Administrator**. The Disk Administrator window opens.
 - b. Click the partition that you want to assign a permanent drive letter.
 - c. Click **Tools → Assign Drive Letter**. The “Assign drive letter” window opens.
 - d. In the **Assign drive letter** menu, click the drive letter for the partition.
 - e. Click **OK**. Windows NT permanently assigns the selected drive letter to that partition, even if you add new partitions or rearrange your controllers.
 - f. To exit the Disk Administrator, click **Partition → Exit**.
2. On Server B, do the following:
 - a. Using the ServeRAID Manager program, scan for new or removed ready drives.
 - b. Run IPSHAHTO.EXE program to move the newly defined logical drive to this server.
 - c. Using the Windows NT Disk Administrator program, assign the same permanent (sticky) drive letter as in step 1.

Perform the following operation on the cluster server that currently owns the shared logical drive. The cluster server that owns the logical drives is the server on which you last ran the IPSHAHTO.EXE program.

1. On the server owning the newly created logical drive, run the Cluster Administration program and open a connection to the installed cluster.
2. To create the ServeRAID disk resource in an existing group, ensure that the cluster server that owns the shared logical drive is the owner of that group. If the cluster server is not the owner of the group, use **Move Group** to make this cluster server the owner of the group where you will create the ServeRAID disk resource. Then, create the ServeRAID disk resource.
3. Bring the new ServeRAID disk group online. If you create a new ServeRAID group, the cluster server that owns the shared logical drive will be the owner of this group by default.
4. Create a ServeRAID disk resource as part of the new group.
5. Bring the ServeRAID disk group online.

Deleting and re-creating a ServeRAID logical drive resource

This section describes how to delete and re-create a ServeRAID logical drive resource without deleting a ServeRAID logical drive.

Complete the following steps to delete a resource or resource group:

1. If the resource or resource group is not currently owned by the cluster server from which you will delete the group, move the resource or resource group to that cluster server.

Note: The cluster service must be running on both systems.

2. To delete the resource, run the Microsoft Cluster Administration program from the cluster server that currently owns the resource or resource group.

Note: You can also run the Microsoft Cluster Administration program from a remote administration system.

Use the normal MSCS procedure for deleting a resource or a group. For instructions, see the documentation that is included with the MSCS package.

Complete the following steps to create a resource:

1. If the group that will own the resource you are creating is not currently owned by the cluster server on which you want to create the resource, move the group to the cluster server.
2. To create the resource, run the Microsoft Cluster Administration program from the cluster server that currently owns the resource group.
Create a new ServeRAID logical disk. For instructions, see “Creating additional ServeRAID disk resources on a Windows NT 4.0 ServeRAID cluster” on page 122.

Uninstalling MSCS on ServeRAID servers

Note: *Do not* use the uninstallation procedure if you are upgrading MSCS on ServeRAID servers. To upgrade MSCS on ServeRAID servers, follow the instructions in “Updating ServeRAID software in an MSCS cluster environment” on page 125.

To uninstall MSCS on ServeRAID servers, you must perform the following procedure on all servers in your cluster:

1. Select one of the cluster servers from which to uninstall MSCS.
2. Click **Start** → **Settings** → **Control Panel**. The Windows NT Control Panel window opens.
3. Double-click **Services**. The Services window opens.
4. Select **Cluster Service** from the list of services; then, click **Stop**.
5. Click **Close** to exit the Services window. For more information, see the documentation that is included with the cluster services.
6. In the Windows NT control panel, double-click **Add/Remove Programs**.
7. Select **Microsoft Cluster Server** from the list of installed components; then, click **Add/Remove**.

Note: Ignore the warnings regarding the removal of IBM ServeRAID Logical Disks.

8. Follow the on-screen prompts by clicking **OK** or **Yes**.
9. After the uninstallation of MSCS is complete, restart the server when prompted.
10. After the server has restarted, click **Start** → **Settings** → **Control Panel**.
11. Double-click **Add/Remove Programs**.
12. Select **IBM ServeRAID Windows NT Cluster Solution** from the list of installed components; then, click **Add/Remove**.
13. Repeat step 1 through step 12 for the other server in the cluster.

Updating ServeRAID software in an MSCS cluster environment

Note: If you are upgrading your ServeRAID software after downloading it from the IBM Support Web site, perform this procedure. If you are installing your software using the *IBM ServeRAID Support CD*, see Chapter 4, “Configuring ServeRAID controllers” on page 35 for instructions.

Important

This upgrade procedure enables the cluster to remain online at all times. To upgrade the cluster, perform the following steps on one server at a time. When all steps are completed for Server A and both servers are reported in the Microsoft Cluster Administrator program as “Up” and all resources are online, repeat the steps for Server B.

Step 1: Ensure cluster availability

Move all cluster resources from Server A to Server B; ensure that the cluster resources are online.

Step 2: Upgrading the IBM ServeRAID Windows NT device driver

Complete the following steps to upgrade the IBM ServeRAID Windows NT device driver on a server in the cluster:

1. Insert the *IBM ServeRAID Support CD* into the CD-ROM drive.
2. Click **Start** in the lower-left corner of the screen; then, click **Settings** → **Control Panel**. The Windows NT Control Panel window opens.
3. Double-click **SCSI-Adapters**.
4. Click the **Drivers** tab.
5. Click **Add**.
6. Click **Have Disk**.
7. For the path, type the following:

```
e:\winnt\driver\nt4_0
```

where *e* is the CD-ROM drive.

8. Click **OK**.
9. When the IBM ServeRAID controller is highlighted, click **OK**.
10. Shut down and restart the server from the CD.

Step 3: Upgrading the IBM ServeRAID BIOS and firmware code

Complete the following steps to upgrade the IBM ServeRAID BIOS and firmware on a server in the cluster:

1. If you have not already done so, start the server with the *IBM ServeRAID Support CD*, version 4.0 or later.
2. When prompted, click **Update** to flash the BIOS code and download the firmware. If no update is required, the ServeRAID Manager program starts.
3. When the download is complete, remove the CD from the CD-ROM drive and press Ctrl+Alt+Del to restart (reboot) the server.
4. Allow the server to rejoin the cluster. When the server is reported in the Microsoft Cluster Administrator program as “Up” and all resources are online, the upgrade for this server is complete.

Step 4: Upgrading the IBM ServeRAID Manager program

To upgrade the ServeRAID Manager program, insert the *IBM ServeRAID Support CD* into the CD-ROM drive. The installation program starts automatically.

Step 5: Upgrading the IBM ServeRAID Microsoft Windows NT Cluster Solution

Complete the following steps to upgrade the IBM ServeRAID Microsoft Windows NT Cluster Solution:

Run the utility SETUP.EXE program from the *IBM ServeRAID Cluster Solution for Windows NT and Windows 2000* diskette or *IBM ServeRAID Support CD*, and follow the instructions that appear on the screen. At a Windows NT command line, type one of the following:

If installing from CD	<code>e:\winnt\cluster\setup</code>
If installing from diskette	<code>a:\setup</code>

where *a* is the diskette drive letter and *e* is the CD-ROM drive letter.

Step 6: Upgrading the software for Server B

Complete the following steps to upgrade the software for Server B:

1. Move all cluster resources to Server A; ensure that the cluster resources are online.
2. For Server B, repeat “Step 2: Upgrading the IBM ServeRAID Windows NT device driver” on page 125 through “Step 5: Upgrading the IBM ServeRAID Microsoft Windows NT Cluster Solution”.

Installing the Microsoft Cluster Server software on Windows 2000

Important

Before beginning the procedure, consider the following:

- Ensure that you use the *IBM ServeRAID Support for Windows 2000 Server* diskette during the installation of Windows 2000 Advanced Server Edition or Windows 2000 Datacenter Server Edition.
- To create a ServeRAID cluster, you must install the Windows 2000 operating system on an NTFS partition, and any shared cluster disks must be formatted as NTFS.
- While installing Windows 2000, do not install Microsoft Cluster Server. You will install MSCS later.
- To install the ServeRAID device driver, see “Installing device drivers after installing Windows 2000” in the *IBM ServeRAID Device Driver Installation Instructions* on the *IBM ServeRAID Support CD*.

Installing the ServeRAID Manager program

Complete the following steps to install the ServeRAID Manager program.

Note: To run ServeRAID Manager as an installed program, you must install both the ServeRAID device driver and the appropriate device driver for your server video controller.

1. If the server is not running, turn on the server.
2. Log on to Windows 2000.
3. Insert the *IBM ServeRAID Support CD* into the CD-ROM drive of Server A. The ServeRAID Manager setup program starts.
4. Click **Next**.
5. Click **Yes** to the Software License Agreement.

6. When prompted to select an operating system, select **Windows NT/Windows 2000**; then, click **Next**.
7. When prompted to install Windows NT Service, click **Yes**; then, click **Next**.
8. Select the **Destination Folder**; then, click **Next**.
9. After setup completes copying the files, click **Finish**.

Installing the Microsoft Cluster Server

To install the Microsoft Cluster Server, complete the following procedure:

1. Use the ServeRAID Manager program to scan for new drives on all ServeRAID controllers.
2. On Server A, run the utility IPSHAHTO.EXE program from the *IBM ServeRAID Windows NT Cluster Solutions Diskette* or the *IBM ServeRAID Support CD*.
3. At a Windows 2000 command line, type one of the following:

If installing from CD	<code>e:\winsrv\cluster\support\ipshahto</code>
If installing from diskette	<code>a:\support\ipshahto</code>

where *a* is the diskette drive letter and *e* is the CD-ROM drive letter.

Running the program makes all the shared logical drives available for access by Server A.

4. Using the right-mouse button, click **My Computer** on the desktop; then, click **Manage**. The Computer Management window opens.
5. In the left pane, click to expand the **Storage** icon; then, click **Disk Management**. The Disk Signature and Upgrade Wizard window opens.
6. To assign disk signatures for the shared disks, click **Next**.
7. Microsoft Cluster Server using Windows 2000 requires you to set shared logical drives to Basic Disk. To do this, click **Cancel** in the Upgrade Disks pane of the window.
8. Format all shared logical drives to NTFS (NT File System), assign volume labels, and specify drive letters for each.

Important

Before creating the ServeRAID logical cluster resource, you must assign a permanent (sticky) drive letter to the shared logical drive on both servers. The two servers must have the same drive letters on each shared drive. If you do not assign permanent drive letters, Windows 2000 might assign different drive letters on each server. Assigning a permanent drive letter ensures that Windows 2000 assigns the same drive letter to the partition on both servers.

Notes:

- a. It is helpful if the volume label contains the drive letter you assigned to the drive, such as DRIVE E.
- b. If you want to use the disk in a cluster, create only one partition on the disk. Make the partition the full size of the disk and format the partition to NTFS.
- c. Make sure that all shared logical drives are the type Basic Disk. If they are marked Dynamic Disk, change them to Basic Disk by doing the following:
 - 1) Right-click the **Disk** icon at the bottom of the Disk Management window (see Figure 40 on page 128).

2) Click **Revert to Basic Disk**.

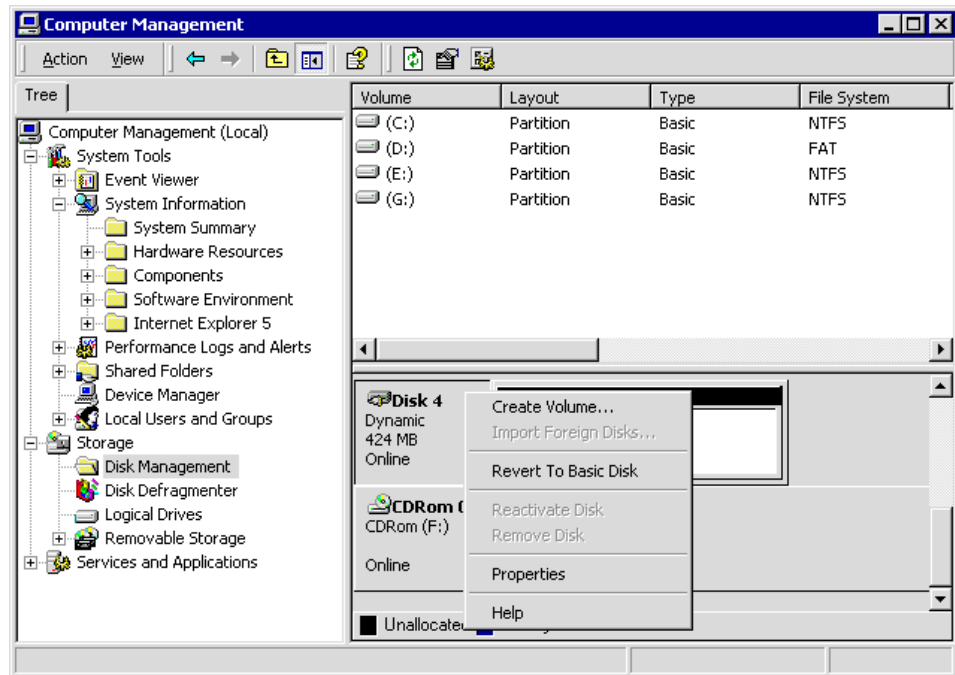


Figure 40. Changing a shared logical drive to Basic Disk

9. On Server B, use the ServeRAID Manager program to scan for new drives on all ServeRAID controllers.
10. On Server B, run the same utility, IPSHAHTO.EXE, to make all shared logical drives available for access by Server B.

Note: If all logical drives are not displayed as okay, there was a problem bringing drives over from the other server. To diagnose the problem, use the log files or the ServeRAID Manager to determine if the drives are critical or offline.

11. Using the Windows 2000 Disk Management Snap-in Computer Management program, scan for new drives and assign them the same drive letters that you assigned to each drive on Server A.

Notes:

- a. Use the disk volume label as a guide to make sure you assign the same drive letters on Server B as you assigned on Server A.
 - b. You might need to press the F5 key multiple times to update the displayed information. Wait until all logical drive letters appear before attempting to change the property of any drives.
 - c. If the Disk Signature Wizard prompts you to write signatures on drives, the drives have not been correctly recognized. Do the following:
 - 1) On Server A, run the IPSHAHTO.EXE utility.
 - 2) After Server A has successfully brought over all drives, run the IPSHAHTO.EXE utility on Server B.
 - 3) Repeat step 11.
12. Run IPSHAHTO.EXE from Server A again, so that control of all shared logical drives returns to Server A.

- Using the Windows 2000 Disk Management Snap-in Computer Management program on Server A, verify that the shared logical drives display with the correct size, volume label, and drive letter.

Note: The drive letters for the shared disks must be the same on each server in the cluster.

- Ensure that both servers are turned on.

Note: If you have a two-node cluster that has a private network consisting of the two servers directly connected to each other using an Ethernet cross-over cable, make sure that *both* servers are turned on before you proceed.

Failure to have both servers turned on will cause Windows 2000 to mark the network adapter as failed, and you will not be able to select it as the private network interface during cluster setup.

- Insert the *IBM ServeRAID Cluster Solution for Windows NT and Windows 2000* diskette or *IBM ServeRAID Support CD* into the Server A diskette or CD-ROM drive.

- Type one of the following and press Enter:

If installing from CD	<code>e:\winsrv\cluster\setup</code>
If installing from diskette	<code>a:\setup</code>

where *a* is the diskette drive letter and *e* is the CD-ROM drive letter. The SETUP.EXE program copies some files and launches the Windows Component Wizard.

- In the Windows Component Wizard, select the check box to install the Cluster Service component; then, click **Next**.
- When prompted, insert the CD labeled *Windows 2000 Advanced Server CD-ROM* into the CD-ROM drive; then, click **OK**. The Microsoft Cluster Server Configuration Wizard opens.

Note: To configure the Microsoft Cluster Server, follow the instructions in the Microsoft Cluster Server documentation.

- After you install and configure the cluster, the IBM ServeRAID Cluster Configuration Wizard opens and applies ServeRAID-specific configurations to the cluster. When prompted, select a shared ServeRAID logical drive on which to set the quorum resources.

Note: Set the quorum resources on a RAID level-1 logical drive. Do *not* set the quorum resources on a RAID level-5 or level-5E logical drive.

- Install the latest Windows 2000 Service Pack on Server A.
- Repeat step 14 through step 18 for Server B.
- Install the latest Windows 2000 Service Pack on Server B. The cluster installation is now complete, and the cluster is ready for use.

See Microsoft Knowledge Base Article Q258750, "Recommended Private 'Heartbeat' Configuration on a Cluster Server," for additional configuration information.

Creating additional ServeRAID disk resources on a Windows 2000 ServeRAID cluster

You can use a ServeRAID logical disk that has not already been designated as a cluster resource, or you can create a new array and logical disk on Server A, using the ServeRAID Manager program. For more information about creating new arrays and logical drives, see Chapter 4, “Configuring ServeRAID controllers” on page 35.

Note: Be sure to assign a unique shared merge-group number to the new shared logical drive.

Important

Before creating the ServeRAID logical cluster resource, you must assign a permanent (sticky) drive letter to the shared logical drive on both servers. The two servers must have the same drive letters on each shared drive. If you do not assign permanent drive letters, Windows 2000 might assign different drive letters on each server. Assigning a permanent drive letter ensures that Windows 2000 assigns the same drive letter to the partition on both servers.

Complete the following steps to create additional ServeRAID disk resources:

1. On Server A, do the following:
 - a. Right-click **My Computer**; then, click **Manage**. The Computer Management window opens.
 - b. Double-click **Storage**.
 - c. Click **Disk Management**. The Write Signature and Upgrade Disk Wizard opens.
 - d. Right-click **Disk Management** → **Rescan Disks**.
 - e. On each of the new disks, complete the following tasks:
 - 1) Right-click a new disk; then, click **Write Signature**. The Write Signature Wizard opens. Follow and complete the wizard.
 - 2) Make sure that all shared logical drives are the type Basic Disk. If they are marked Dynamic Disk, change them to Basic Disk by doing the following:
 - a) Right-click the **Disk** icon at the bottom of the Disk Management window.
 - b) Click **Revert to Basic Disk**.
 - 3) Create one partition on the disk (the full size of the disk), assign a drive letter, and format the partition to NTFS.

Note: To help recognize the drive on the cluster partner server, assign a descriptive volume label that includes the drive letter.

2. On Server B, do the following:
 - a. Using the ServeRAID Manager program, scan for new or removed ready drives on all ServeRAID controllers.
 - b. To move the newly defined logical drive to Server B, start the IPSHAHTO.EXE program by typing:

```
%systemroot%\cluster\ipshahto.exe
```

where *%systemroot%* is expanded by the operating system to the root directory of the operating system on Server B.

- c. Using the Windows 2000 Disk Management Snap-in Computer Management program, assign the same drive letters that you assigned to the new drives on Server A.

Note: Use the disk volume label as a guide to make sure you assign the same drive letters on Server B as you assigned on Server A.

- d. To create a new ServeRAID disk resource and group for each newly defined logical drive on Server B, start the MSCSCFG.EXE program by typing:

```
%systemroot%\cluster\mscscfg.exe
```

where `%systemroot%` is expanded by the operating system to the root directory of the operating system on Server B.

Deleting and re-creating a ServeRAID logical drive resource

This section describes how to delete and re-create a ServeRAID logical drive resource without deleting a ServeRAID logical drive.

Complete the following steps to delete a resource or resource group:

1. To delete the resource, run the Microsoft Cluster Administration program from the cluster server that currently owns the ServeRAID resource or resource group.

Notes:

- a. The cluster service must be running on both servers.
- b. You can also run the Microsoft Cluster Administration program from a remote administration system.
2. Use the normal MSCS procedure for deleting a resource or a group. For instructions, see the documentation that is included with the MSCS package.
3. After deleting the ServeRAID resource, shut down and restart the cluster server from which the resource was deleted.

Note: Restarting one cluster server will *not* shut down the entire cluster.

To create the new ServeRAID disk resource and group for the ServeRAID logical drive, start the MSCSCFG.EXE program by typing:

```
%systemroot%\cluster\mscscfg.exe
```

where `%systemroot%` is expanded by the operating system to the root directory of the operating system on Server B.

Upgrading the IBM ServeRAID Cluster Solution from Microsoft Windows NT 4.0 to Windows 2000

Complete the following steps to upgrade from Windows NT 4.0 with Service Pack 5 (or later) to Windows 2000 Advanced Server.

Note: Before upgrading from Windows NT 4.0 Enterprise Edition, make sure you have updated Windows NT 4.0 Enterprise Edition with the latest Service Pack on both Server A and Server B.

1. On the server that you want to upgrade, click **Start** → **Programs** → **Administrative Tools** → **Cluster Administrator**.
2. Move all cluster resources and groups to the other cluster node (that is, the server that is *not* running the Cluster Administrator program).

3. Insert the *IBM ServeRAID Support CD* (version 4.0 or later) into the CD-ROM drive; then, type the following command and press Enter:
`e:\winsrv\cluster\setup.exe`

where *e* is the CD-ROM drive.

4. When prompted A previous installation of "IBM ServeRAID NT Cluster Solution" has been found. Do you want to upgrade?, click **Yes**.
5. When prompted You are currently running Windows NT 4.0. Is this upgrade to "IBM ServeRAID NT Cluster Solution" being done as procedure to upgrade cluster to run Windows 2000?, click **Yes**.
6. The IBM ServeRAID Windows NT Solution Setup program copies the necessary Windows 2000 files; then, it prompts you to upgrade the server to Windows 2000.

Note: After you complete this step, you can no longer use this server as a Windows cluster node.

7. Insert the *Microsoft Windows 2000 Advanced Server CD* into the CD-ROM drive.
8. Run the Windows 2000 Advanced Server Setup program to upgrade this node to Windows 2000. After successfully upgrading the server, it joins the cluster.

Note: If your cluster installation includes ServeRAID-4M, ServeRAID-4Mx, ServeRAID-4L, or ServeRAID-4Lx controllers, you must manually install the ServeRAID device driver. To do so, complete the following steps:

- a. When Windows 2000 restarts the first time, the Windows 2000 Setup window opens.
- b. Press F6 promptly. You have only a few seconds to press this key.
- c. Select the **IBM ServeRAID 4M/4Mx/4L/4Lx (Windows 2000)** device driver.

For additional information about installing ServeRAID device drivers, see the *IBM ServeRAID Device Driver Installation Instructions* (DEVDRV51.PDF) on the *IBM ServeRAID Support CD*.

9. Repeat step 1 on page 131 through step 8 for the other server in the cluster.

Uninstalling MSCS on ServeRAID servers

Complete the following steps to uninstall MSCS from a ServeRAID server using Windows 2000 Advanced Server:

1. On the server you want to remove from the cluster, click **Start → Programs → Administrative Tools → Cluster Administrator**.
2. Move all cluster resources and groups to the other cluster server (that is, the server that is *not* running the Cluster Administrator program).
3. In the tree view, click the server from which you want to remove MSCS.
4. Using the right-mouse button, click **Stop Cluster Service**; then, click **Evict Node**.
5. Click **Start → Settings → Control Panel**. The Control Panel window opens.
6. Double-click **Add/Remove Programs**. The Add/Remove Programs window opens.
7. In the left pane, click **Add/Remove Windows Components**. The Windows Components Wizard opens.
8. Deselect **Cluster Service** in the Components list; then, click **Next**.

9. After the Microsoft Cluster Server is uninstalled, the Windows Component Wizard prompts you to restart the server.
10. After the server restarts, click **Start → Settings → Control Panel**. The Control Panel window opens.
11. Double-click **Add/Remove Programs**. The Add/Remove Programs window opens.
12. Select IBM ServeRAID NT Cluster Solution from the list of installed components.
13. To uninstall the IBM ServeRAID Windows NT Cluster Solution, click **Change/Remove**.

If you uninstall clustering on Windows 2000, you might not be able to access the ServeRAID logical drives shared by the two nodes of the cluster. If this occurs, do one of the following:

- Delete the logical drives and restart the server.
- Set the logical drives to non-shared by changing the merge-group numbers. Use the ServeRAID Manager program in startable-CD mode to make this change.

Note: If you use the installed version of the ServeRAID Manager program to delete and recreate the logical drives that have the same merge-group number, you will not be able to access the logical drives. You must delete the logical drives, restart the server, and re-create the logical drives.

Chapter 15. Monitoring and updating an IBM ServeRAID Cluster Solution

You can use the ServeRAID Manager program to check the ownership of a physical drive on another server or to add or remove a logical drive in the cluster. The ServeRAID Manager program supports three features for cluster functions:

- View shared drives
- Validate cluster
- Configure for clustering

Note: Make sure that you installed the ServeRAID Manager program on your server. For instructions, see “Installing the ServeRAID Manager program” on page 93.

Checking the ownership of a physical drive

A physical drive that is owned (and configured) on Server B will appear in the ready or defunct state on Server A. Complete the following steps to determine whether a ready drive is owned by the other server:

1. In the ServeRAID Manager tree, click the controller that contains the ready drives. A window similar to the following opens.

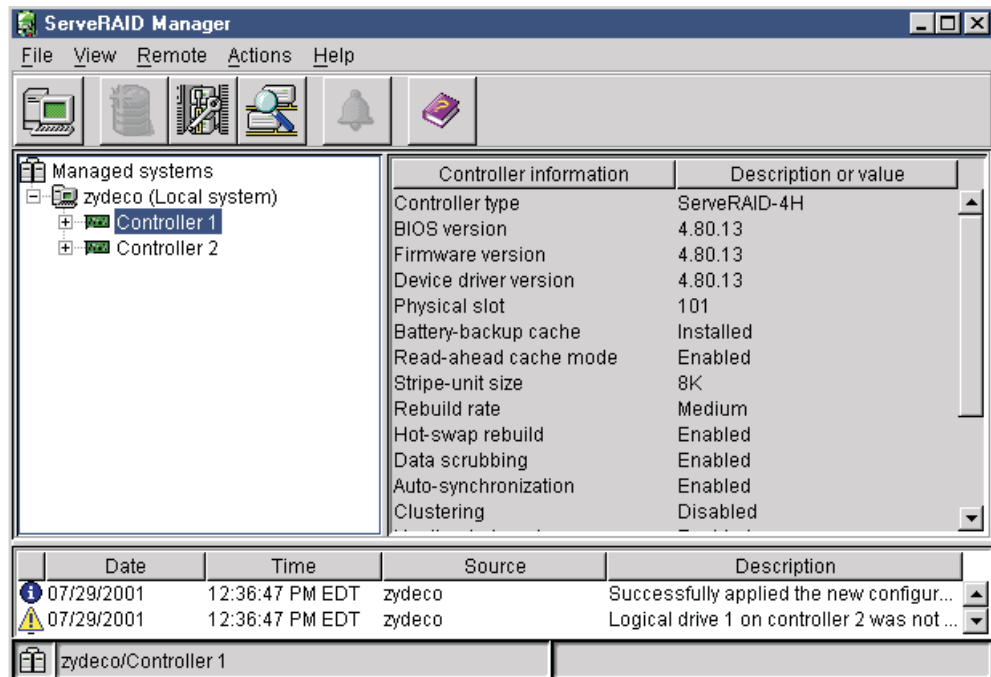


Figure 41. ServeRAID Manager window

2. Click **Actions** → **Clustering actions** → **View shared drives**. The “View shared drives” window opens.
3. Click **Enable view shared drives**.
4. Select the SCSI channel and SCSI ID of a physical drive on a shared channel.

- Click **OK**. Physical drives that are available for use are labeled **Ready** in the tree. If the physical drive is not available for use (that is, it is owned by the other server), the drive is labeled **Reserved** in the tree.

Important

Hot-spare drives owned by the other server are not labeled **Reserved**. Be sure you do not inadvertently use a hot-spare drive in *both* servers.

Adding logical drives to a cluster

Complete the following steps to add logical drives to a cluster:


- Install the hard disk drives in the server or shared expansion enclosure. For installation information, see the documentation that is included with the hard disk drive and the server.

Important

Physical drives that are configured by one controller in the pair must appear as ready drives to the other controller in the pair. Be sure to verify this status when you add drives *after* the servers are started. Before creating logical drives, restart both servers, or scan for new drives using the ServeRAID Manager program on both servers, to make sure the added physical drives appear as ready drives on both servers. For more information, see “ServeRAID considerations” on page 108.

- Using the ServeRAID Manager program, configure the physical drives for the ServeRAID controller. For instructions, see Chapter 4, “Configuring ServeRAID controllers” on page 35.

Note: If the drives will be shared, define only one logical drive per array.

- In the ServeRAID Manager tree, click the controller for the cluster.
- Click  (Configure for clustering) on the toolbar. A window similar to the following opens.

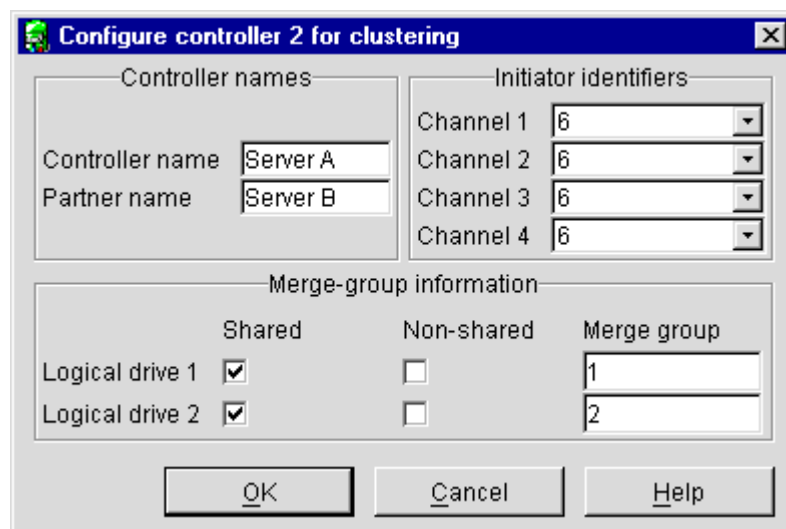


Figure 42. “Configure for clustering” window

- Click **Shared** or **Non-shared** for the logical drive you have just defined.

6. Select the merge-group number that you want to use for the logical drive you just defined.
7. Click **OK**.
8. If you are using Windows NT 4.0, continue with “Creating additional ServeRAID disk resources on a Windows NT 4.0 ServeRAID cluster” on page 122.
If you are using Windows 2000, continue with “Creating additional ServeRAID disk resources on a Windows 2000 ServeRAID cluster” on page 130.

Validating a cluster

Use the Validate cluster feature to determine whether your cluster is configured correctly.

Note: You must have the ServeRAID Manager program installed and running on all servers in the cluster for this feature to work.

Complete the following steps to validate a cluster:

1. In the ServeRAID Manager tree, click a server in the cluster.
2. Click **Actions** → **Validate cluster**. A window similar to the following opens.

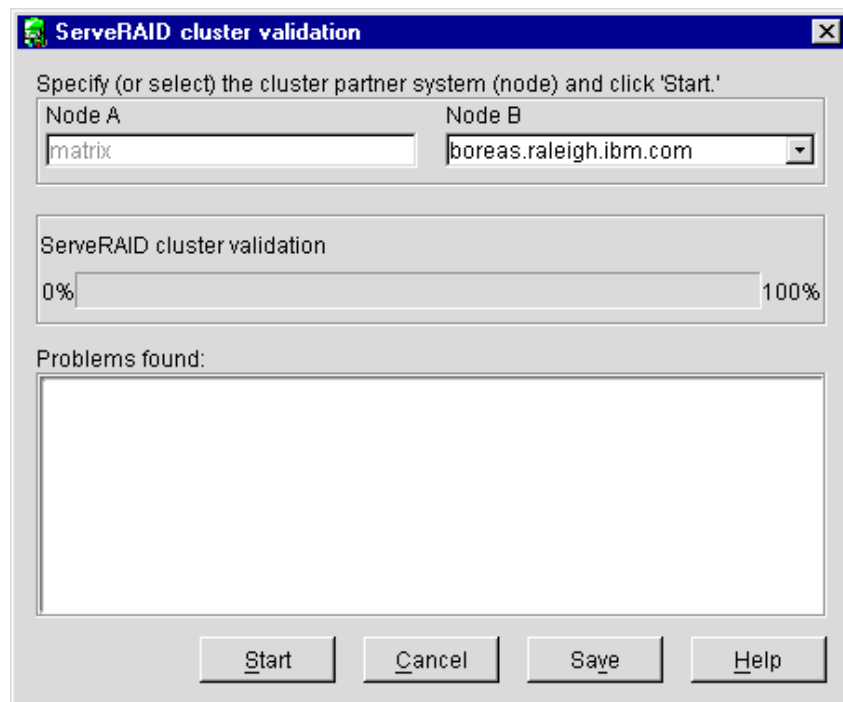


Figure 43. “ServeRAID cluster validation” window

The server you selected in step 1 is listed in the Node A field.

Note: You cannot change the Node A system in the “ServeRAID cluster validation” window. To select a different system, click **Cancel** to return to the ServeRAID Manager tree.


3. From the **Node B** menu, select your second server.

Note: The Node B system defaults to the first system in the tree other than the Node A system. If there are no remote systems in the tree, click **Cancel** to return to the tree and add a remote system. You can also type the Node B name.

4. Click **Start**. The ServeRAID Manager program scans both systems to verify the ServeRAID cluster configuration. The progress indicator reports the progress of the validation.
5. If you want to stop the validation before it is completed, click **Cancel**. Otherwise, if the ServeRAID Manager program finds problems with the ServeRAID cluster configuration, it reports the problems in the **Problems found** message field. If there are no problems with the ServeRAID cluster configuration, the message field reports only the cluster pairings found.
6. To view the problem report events in an easy-to-read window, double-click an event in the **Problems found** message field.
7. To save the contents of the **Problems found** message field, click **Save**. A “Save as” window opens. Specify the file name for the message field log and click **OK**.
8. Click **Done** to exit the “ServeRAID cluster validation” window. If the ServeRAID cluster configuration has problems, fix the problems; then, use **Validate cluster** again.

Viewing merge-group numbers and other cluster information

Complete the following steps to view the merge-group numbers and other cluster information:

1. In the ServeRAID Manager tree, click the controller you are using for the cluster.
2. Click  (Configure for clustering) on the toolbar. A window similar to the following opens.

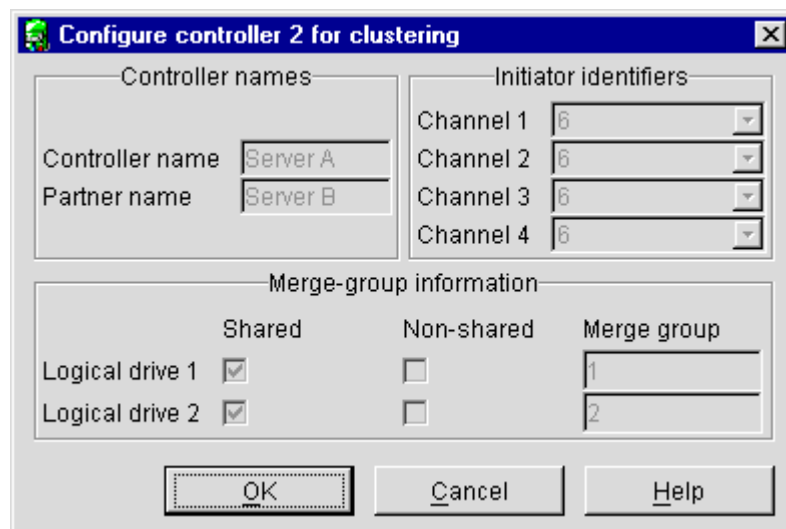


Figure 44. “Configure controller for clustering” window

Note: In this case, you can view this information only. You cannot change the information.

Part 4. Maintenance and troubleshooting

Chapter 16. Obtaining ServeRAID updates

IBM periodically makes updated versions of the ServeRAID software available from the IBM Support page on the World Wide Web.

Note: If you download ServeRAID software, you must download and install *all* ServeRAID software at the same time. This will ensure that all levels of the software are compatible. The ServeRAID software includes the following:

- BIOS and firmware code
- Device drivers
- ServeRAID Manager program
- Command-line programs

If you do not have access to the World Wide Web, contact your place of purchase, your IBM reseller, or your IBM marketing representative for replacement CDs.

Downloadable files from the World Wide Web

You can download files for the IBM ServeRAID products from the IBM Support Web site.

Complete the following steps to locate files:

1. Go to <http://www.ibm.com/pc/support/>.
2. In the **Search** field at the top of the page, type ServeRAID; then, press Enter.

Updating the ServeRAID BIOS, firmware, and software code for clustering

Use the following CD and diskettes:

- *IBM ServeRAID Support CD*
- The appropriate *IBM ServeRAID Support* diskette for your Windows operating system
- The *IBM ServeRAID Cluster Solution for Windows NT and Windows 2000* diskette

Ensure that the ServeRAID controllers have the latest IBM ServeRAID software installed.

Ensure that you are using a version of the ServeRAID software that has been certified by Microsoft for Windows 2000 and Windows NT 4.0 compatibility, as noted on the IBM Support Web site.

Note: If you are using Windows 2000, check the Windows 2000 Hardware Compatibility List (HCL) included on the *Windows 2000 Advanced Server* CD or the IBM ServerProven® List on the IBM Support Web site to determine if your server devices are supported by the Windows 2000 operating system. If not, contact the device manufacturer to receive a device driver for Windows 2000.

Chapter 17. Upgrading a ServeRAID controller

This section contains instructions for upgrading a ServeRAID controller. The following table displays possible upgrade scenarios.

Existing controller	Upgrade to ServeRAID-II	Upgrade to ServeRAID-3	Upgrade to ServeRAID-4
ServeRAID-II	Yes	Yes	Yes
ServeRAID-3	No	Yes	Yes
ServeRAID-4	No	No	Yes

Backward compatibility is not supported. In addition, you must usually upgrade to a controller with the same or greater number of channels; upgrading to a controller with fewer number of channels is possible only if the new controller contains as many or more channels than those actually used on the original controller.

You must select a ServeRAID controller that meets the conditions outlined above. After updating the device driver, BIOS and firmware code, and utility programs, you can replace the older controller with the new controller and copy the configuration from the physical drives.

Notes:

1. When upgrading an existing system, you *must* update the device driver before flashing the controller with the new BIOS and firmware code.
2. This procedure assumes that you are replacing an existing ServeRAID controller in a fully functioning system.

Updating device drivers, BIOS and firmware code, and utility programs

Complete the following steps to upgrade the device driver, BIOS and firmware code, and utility programs:

1. Install the device driver for the new ServeRAID controller. For more information, see the *IBM ServeRAID Device Driver Installation Instructions* (DEVDRV51.PDF) on the *IBM ServeRAID Support CD*.
2. Update the BIOS and firmware code for your existing ServeRAID controller, using the *IBM ServeRAID Support CD* that came with the new controller. For more information, see “Updating BIOS and firmware code” on page 35.
3. If the IPSEND command-line program is currently installed on the server, upgrade to the latest version. For more information, see “Installing the IPSEND command-line program” on page 71.
4. Upgrade or install the ServeRAID Manager program. For more information, see “Installing the ServeRAID Manager program” on page 93.
5. Ensure that the server is functioning properly before continuing to “Replacing the old controller”.

Replacing the old controller

Complete the following steps to replace the old controller:

1. Shut down the server.
2. Make note of which SCSI cables were attached to specific channels.
3. Remove any cables from the old controller; remove the controller.

4. Insert the new controller into a PCI slot. If possible, use the PCI slot in which the old controller was inserted.
5. Attach the SCSI cables to the new controller.

Note: If the new controller has the same number of channels as the old controller, attach storage devices to the same channels as used previously.

6. Insert the *IBM ServeRAID Support CD* into the server CD-ROM drive, and turn on the server. The IBM ServeRAID ROM Update Wizard automatically starts. If the BIOS and firmware code do not require updating, the wizard automatically stops, and the ServeRAID Manager starts. Go to step 7. If necessary, update the BIOS and firmware code for the new controller. Leave the *IBM ServeRAID Support CD* in the CD-ROM drive; shut down and start the server.
7. After the ServeRAID Manager program starts, click the new controller in the left pane.
8. Click **Actions** → **Restore to factory-default settings**.
9. Click **Actions** → **Copy configuration from drives**.
10. Shut down the server, and remove the *IBM ServeRAID Support CD* from the CD-ROM drive.
11. Restart the server.

Chapter 18. Solving ServeRAID problems

This section describes the ServeRAID text and numeric messages that might be displayed during startup. This section also includes some basic information about rebuilding a defunct drive.

IBM ServeRAID Support CD warning message while starting

If you start a server with the *IBM ServeRAID Support CD* in the CD-ROM drive, the following warning message might be displayed:

```
You passed an undefined mode number.  
Press <RETURN> to see video modes available,  
<SPACE> to continue or wait 30 secs
```

Press the Spacebar to continue starting the *IBM ServeRAID Support CD*. The following message appears, and the CD starts:

```
Uncompressing Linux... Ok, booting the kernel.
```

ServeRAID controller messages

This section lists the ServeRAID messages that might appear during system startup.

The ServeRAID controllers provide a device event log that collects statistics on the number and types of events that occur on a selected physical drive. After correcting a problem with the disk array, clear the log so that you can identify any subsequent errors quickly. For information about clearing the event log, see “eraseevent” on page 86.

All physical drives contain unique identifiers, such as the drive serial number and manufacturer. During configuration, the ServeRAID controller stores this information.

The following are the messages associated with the ServeRAID subsystem listed in alphabetical order.

Message	Explanation	Action
A new drive was installed.	When the ServeRAID controller detects a new drive that is not part of the current configuration, the following message appears: x new Ready drives found where x is the number of ready drives found.	This is an information message. No action is required.
Auto rearrange.	Auto rearrange is enabled or disabled.	This is an information message. No action is required.
Battery-backup cache not responding.	BIOS code detected a bad or failed battery-backup cache.	Press F9 to remove the battery-backup cache from the configuration, or press F10 to exit without change.
Battery-backup cache replacement.	The ServeRAID controller detects that the battery-backup cache is defective.	If the battery-backup cache must be replaced, contact your IBM service representative. Press F8 if you replaced the battery-backup cache, or press F10 if you have not replaced the battery-backup cache.

Message	Explanation	Action
<p>Configured drives are missing.</p>	<p>When the ServeRAID controller detects that a previously configured drive is missing, the following message appears:</p> <p><code>x Online drive(s) not responding or found at new location(s)</code></p> <p>where <i>x</i> is the number of drives not responding.</p> <p>After pressing F2, a more detailed message appears:</p> <p><code>Online Drive on Channel x SCSI ID y is not responding.</code></p> <p>where <i>x</i> is the channel ID and <i>y</i> is the SCSI ID.</p>	<p>Press one of the following keys:</p> <p>F2 Detailed description. Press this key for a detailed description of the problem.</p> <p>F4 Retry. Press this key after correcting a problem. For example, press F4 after you turn on the external storage enclosure that contains the physical drive.</p> <p>F5 Change the configuration and set the drives to defunct. Press this key to accept the new state that the ServeRAID controller will assign to the drive. For example, the ServeRAID controller will assign the drive a state of defunct or empty.</p> <p>You also can press F5 when you must remove a drive. RAID level-1 and RAID level-5 logical drives are present, and performance in a degraded mode is acceptable. The ServeRAID controller will assign the drive a state of defunct, but the server can complete startup. However, the array will remain in the critical state and the potential for data loss will exist until you replace and rebuild the defunct drive. To prevent the loss of data, replace and rebuild the defunct drive in a timely manner.</p> <p>Note: A physical drive in the defunct state does not necessarily mean that you need to replace the drive. Before you replace the drive, ensure that:</p> <ol style="list-style-type: none"> 1. All cables are connected properly to the backplane and to the physical drive. Also, ensure that all cables inside the server are connected properly. 2. The hot-swap drive trays are seated properly in the drive bay. 3. If multiple drives fail in separate arrays (one physical drive per array), replace each of the defunct physical drives. If multiple physical drives fail at the same time within the <i>same</i> array, contact your IBM service representative. See "Rebuilding a defunct drive" on page 157 for more information. <p>After you perform these steps, if the physical drive does not function properly, replace the drive.</p> <p>F10 Continue starting without changing the configuration. Press this key to continue without change to the configuration.</p>

Message	Explanation	Action
Configured drives are not in the configured location.	<p>When the ServeRAID controller detects that a previously configured drive is present but the drive is in a new location, the following message appears:</p> <p><code>x Online drive has been rearranged</code></p> <p>where <i>x</i> is the number of drives that have been rearranged.</p> <p>After pressing F2, a more detailed message appears:</p> <p><code>Online Drive on Channel <i>w</i> SCSI ID <i>x</i> moved to Channel <i>y</i> SCSI ID <i>z</i></code></p> <p>where <i>w</i> and <i>y</i> are the channel numbers, and <i>x</i> and <i>z</i> are the SCSI IDs.</p>	<p>Press one of the following keys:</p> <p>F2 Detailed description. Press this key for a detailed description of the problem.</p> <p>F4 Retry. Press this key after correcting a problem. For example, press F4 after you move the physical drive to its previously assigned location.</p> <p>F5 Change the configuration and set the drive to defunct. Press this key to accept the new state that the ServeRAID controller will assign to the drive. For example, the ServeRAID controller will assign the drive a state of defunct or empty. Note: A physical drive in the defunct state does not necessarily mean that you need to replace the drive. Before you replace the drive, ensure that:</p> <ol style="list-style-type: none"> 1. All cables are connected properly to the backplane and to the physical drive. Also, ensure that all cables inside the server are connected properly. 2. The hot-swap drive trays are seated properly in the drive bay. 3. If multiple drives fail in separate arrays (one physical drive per array), replace each of the defunct physical drives. If multiple physical drives fail at the same time within the <i>same</i> array, contact your IBM service representative. See "Rebuilding a defunct drive" on page 157 for more information. <p>After you perform these steps, if the physical drive does not function properly, replace the drive.</p> <p>F6 Change the configuration and accept the rearrangement. Press this key to change the configuration to match the current drive location.</p> <p>You might remove the hot-swap drives from the server for security or maintenance reasons. If you replace the drives but install them in different drive bays, you can press F6 to accept the new locations, and the ServeRAID controller will update the configuration.</p> <p>F10 Continue startup without changing the configuration. Press this key to continue without change to the configuration.</p>
Controller is not responding to commands. No logical drives are installed.	The ServeRAID controller is not operational.	Contact your IBM service representative.
Error: Cannot disable this controller BIOS.	The ServeRAID controller was unable to prevent an extra copy of its BIOS code from being stored on the server. This condition occurs when the server contains multiple ServeRAID controllers.	Contact your IBM service representative.

Message	Explanation	Action
Installation stopped.	The server cannot access the ServeRAID controller.	This is a follow-on message to a preceding message. Follow the Action instructions for the preceding message to resolve the problem.
New controller installed in a configured server or drives are imported.	<p>When the ServeRAID controller detects that the identifiers of the drives do not match the controller configuration information, the following message appears:</p> <p><i>x</i> Online drive(s) found with incorrect configuration</p> <p>where <i>x</i> is the number of drives found with incorrect configuration.</p> <p>After pressing F2, a more detailed message appears:</p> <p>Configuration mismatch Channel <i>x</i> with Host ID <i>y</i></p> <p>where <i>x</i> is the channel number and <i>y</i> is the Host ID.</p>	<p>Press one of the following keys:</p> <p>F2 Detailed description. Press this key for a detailed description of the problem.</p> <p>F4 Retry. Press this key after correcting the problem. For example, press F4 after you move the physical drive to its previously assigned location, or after you install the original physical drives back in the server.</p> <p>F5 Change the configuration and set the drive to defunct. Press this key to accept the new state that the ServeRAID controller will assign to the drive. For example, the ServeRAID controller will assign the drive a state of defunct or empty. Note: A physical drive in the defunct state does not necessarily mean that you need to replace the drive. Before you replace the drive, ensure that:</p> <ol style="list-style-type: none"> 1. All cables are connected properly to the backplane or system board and to the physical drive. Also, ensure that all cables inside the server are connected properly. 2. The hot-swap drive trays are seated properly in the drive bay. 3. If multiple drives fail in separate arrays (one physical drive per array), replace each of the defunct physical drives. If multiple physical drives fail at the same time within the <i>same</i> array, contact your IBM service representative. See "Rebuilding a defunct drive" on page 157 for more information. <p>After you perform these steps, if the physical drive does not function properly, replace the drive.</p>

Message	Explanation	Action
		<p>F7 Import configuration information from drive. Press this key to restart the server. Press this key to import the configuration information from the drive and to update the configuration information for the ServeRAID controller. This choice is useful when you replace the ServeRAID controller in an existing ServeRAID subsystem.</p> <p>You also might press F7 if you replace a whole set of drives with drives that were configured in another server with a ServeRAID controller.</p> <p>Note: When you install drives in a server that has no logical drives defined, the F7 choice will not appear. The ServeRAID controller does not contain any logical drives in its factory configuration. Therefore, F7 will not appear. In this case, do the following:</p> <ol style="list-style-type: none"> 1. Restart the server and press Ctrl+I to start the Mini-Configuration program. (See Chapter 7, “Using the ServeRAID Mini-Configuration program” on page 67 for more information.) 2. Select Advanced Functions. 3. Select Copy the Configuration from Drives to the Controller and follow the instructions on the screen.
Recoverable configuration error.	The configuration data stored in NVRAM does not match the configuration data stored in the EEPROM.	<ol style="list-style-type: none"> 1. Press Ctrl+I to access the ServeRAID Mini-Configuration menu. (See Chapter 7, “Using the ServeRAID Mini-Configuration program” on page 67 for more information.) 2. Select Advanced Functions from the main menu. 3. Select Copy the Configuration from Drives to the Controller. (See “Using the advanced configuration functions” on page 68 for more information.)
Unrecoverable configuration error.	The configuration data stored in NVRAM does not match the configuration data stored in the EEPROM.	<ol style="list-style-type: none"> 1. Press Ctrl+I to access the ServeRAID Mini-Configuration menu. (See Chapter 7, “Using the ServeRAID Mini-Configuration program” on page 67 for more information.) 2. Select Advanced Functions from the main menu. Attention: Restoring to factory-default settings sets all online drives in an array to ready. You must import the configuration from the drives or diskette. Otherwise, you must create a new array and logical drives. When you create new logical drives, they are automatically initialized. All data is lost and you must reinstall the operating system and data. 3. Select Restore to the Factory-Default Settings. (See “Using the advanced configuration functions” on page 68 for more information.)
WARNING: n logical drives are critical; n logical drives are offline.	One or more physical drives have failed.	Replace the defunct drives as soon as possible to prevent data loss.

Message	Explanation	Action
Your server has an error due to a Blocked Logical Drive.	One or more logical drives are blocked. A blocked logical drive cannot be accessed. See “Logical-drive-state descriptions” on page 32 and “Rebuilding a defunct drive” on page 157 for more information.	Press F4 to unblock the logical drive, or press F5 to continue without unblocking.

ServeRAID startup (POST) messages

During power-on self-test (POST), the ServeRAID controller compares the stored configuration information to the configuration that is actually present. If a discrepancy exists, one or more status messages appear after POST is completed, but before the operating system starts.

```

IBM ServeRAID BIOS
Copyright IBM Corp. 1995, 2001
BIOS Version: 4.10.05

Controller 1 Slot 4, Logical Drive=1, Firmware=4.00.20, Status=Fail
2 Drive(s) not responding or found at new location(s)

Press: F2 - Detailed information
      F4 - Retry
      F5 - Change the configuration and set drive(s) defunct
      F10 - Continue booting without changing the configuration

```

When you press F2 for detailed information, the following register information appears on the screen.

```

Detailed information
-----
Online Drive on Channel 2 SCSI ID 0 is not responding
Online Drive on Channel 2 SCSI ID 1 is not responding
-----
Controller Status Codes: ISPR = EF10 BCS = 07 ECS = 08

Press PgUp = Page Up   PgDn = Page Down   Esc = Exit panel

```

The controller status codes include the interrupt status port register (ISPR) code, the basic configuration status (BCS) register code, and the extended configuration status (ECS) register code.

If no errors occur during POST, the following register information is displayed: ISPR = EF10, BCS = 0F or 09, and ECS = 00

If an error occurs, see “ISPR register codes” on page 151 for the ISPR error codes and “BCS and ECS register codes” on page 151.

ISPR register codes

Code	Explanation	Action
1xxx to 7xxx	The POST detected an internal error.	Contact your IBM service representative.
2601 to 260B	The POST detected an error with the ServeRAID subsystem.	Contact your IBM service representative.
2610	The POST detected an error with the ServeRAID controller hardware.	Contact your IBM service representative.
2620	The POST detected that a ServeRAID configuration or hard disk error occurred.	Start the <i>IBM ServeRAID Support</i> CD and view the existing device and configuration information for your ServeRAID subsystem. If you cannot locate and correct the configuration problem or the failing device, or if the problem persists, contact your IBM service representative.
3E20H	The POST detected that the ServeRAID-5i controller is in the wrong PCI expansion slot.	Install the ServeRAID-5i controller in the correct PCI expansion slot. See the documentation that came with your server for more information.
3E2xH	The POST detected an error.	Contact your IBM service representative.
8xxx to Bxxx	The POST detected an error with the SCSI interface.	Verify that the SCSI cables are correctly connected and the SCSI termination is set properly for each installed SCSI device. If you cannot locate and correct the SCSI problem, or if the problem persists, contact your IBM service representative.

BCS and ECS register codes

Notes:

1. When the ServeRAID controller requires your input, a list of function keys will be displayed below the message.
2. Where the Action information tells you to start the IBM ServeRAID configuration program, insert the *IBM ServeRAID Support* CD into the CD-ROM drive; then, restart the server. The Action column also provides general information about the message.

BCS	ECS	Explanation	Action
Code not in table	Code not in table	The ServeRAID controller is not functioning properly.	Contact your IBM service representative.
00	01	Invalid flash configuration.	Start the <i>IBM ServeRAID Support</i> CD and follow the instructions that appear on the screen. If no instructions appear or if the problem persists, contact your IBM service representative.
00	02	Invalid NVRAM configuration.	
00	03	Invalid flash and NVRAM configuration.	

BCS	ECS	Explanation	Action
01	08	No configuration was found in drives, or the online/rebuild drives are not responding.	<p>To correct the problem:</p> <ol style="list-style-type: none"> 1. If the controller is connected to an enclosure, verify that the enclosure is on. If the enclosure is off, turn on the power and press F4 to retry. 2. Verify that all the physical drives are present. If any drives are missing, replace the drives and press F4 to retry. 3. Verify that all the physical drives are connected to the controller correctly. If any drives are unconnected, connect the drives and press F4 to retry. 4. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. 5. If you have intentionally switched physical drives that are connected to this controller, press F7 to import the configuration from the drives and account for the drive rearrangement. <p>To exit without making changes, press F10.</p>
01	18	No configuration was found in drives, or the online/rebuild and hot spare/standby hot-spare drives are not responding.	
01	28	No configuration was found in drives, or the online/rebuild and ready/standby drives are not responding.	
01	38	No configuration was found in drives, or the online/rebuild, hot spare/standby hot-spare, and ready/standby drives are not responding.	
01	48	No configuration was found in drives, or the online/rebuild drives are not responding and unidentified drives were found.	
01	58	No configuration was found in drives, or the online/rebuild and hot spare/standby hot-spare drives are not responding and unidentified drives were found.	
01	68	No configuration was found in drives, or the online/rebuild and ready/standby drives are not responding and unidentified drives were found.	
01	78	No configuration was found in drives, or the online/rebuild, hot spare/standby hot-spare, and ready/standby drives are not responding and unidentified drives were found.	

BCS	ECS	Explanation	Action
03	88	A drive was imported from another server and it has a valid configuration, and the online/rebuild drives are not responding.	<p>To correct the problem:</p> <ol style="list-style-type: none"> To keep the previous configuration in the controller, replace the physical drives that were switched and press F4 to retry. Attention: Completing step 2 might result in a loss of the original configuration and data on the drives. To accept the new configuration from the physical drives, press F7. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. <p>To exit without making changes, press F10.</p>
03	98	A drive was imported from another server and it has a valid configuration, and the online/rebuild and hot spare/standby hot-spare drives are not responding.	
03	A8	A drive was imported from another server and it has a valid configuration, and the online/rebuild and ready/standby drives are not responding.	
03	B8	A drive was imported from another server and it has a valid configuration, and the online/rebuild, hot spare/standby hot-spare, and ready/standby drives are not responding.	
03	C8	A drive was imported from another server and it has a valid configuration, and the online/rebuild drives are not responding and unidentified drives were found.	
03	D8	A drive was imported from another server and it has a valid configuration, and the online/rebuild and hot spare/standby hot-spare drives are not responding and unidentified drives were found.	
03	E8	A drive was imported from another server and it has a valid configuration, and the online/rebuild and ready/standby drives are not responding and unidentified drives were found.	
03	F8	A drive was imported from another server and it has a valid configuration, and the online/rebuild, hot spare/standby hot-spare, and ready/standby drives are not responding and unidentified drives were found.	
07	00	The specified drive is not responding.	<p>To correct the problem:</p> <ol style="list-style-type: none"> If the specified physical drive or drives are in an external enclosure, verify that the enclosure is turned on. If the enclosure is turned off, turn on the power and press F4 to retry. Download and install the latest version of IBM ServeRAID software. See Chapter 16, "Obtaining ServeRAID updates" on page 141 for more information. Replace the failed physical drive or drives.
07	08	The specified drives are not responding.	

BCS	ECS	Explanation	Action
07	0C	Online/rebuild drives are not responding, and a drive was found at the incorrect SCSI ID.	<p>To correct the problem:</p> <ol style="list-style-type: none"> To keep the previous configuration in the controller, replace the physical drives and cable connections that were switched or moved; then, press F4 to retry. Note: Pressing F4 might not correct the problem. If you do not return the drives and cables to the previous configuration, the message might return. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. To modify the configuration and accept the rearrangement of the physical drives, press F6. <p>To exit without making changes, press F10.</p>
07	1C	Online/rebuild and hot spare/standby hot-spare drives are not responding, and a drive was found at the incorrect SCSI ID.	
07	2C	Online/rebuild and ready/standby drives are not responding, and a drive was found at the incorrect SCSI ID.	
07	3C	Online/rebuild, ready/standby, and hot spare/standby hot-spare drives are not responding, and a drive was found at the incorrect SCSI ID.	
07	4C	Online/rebuild drives are not responding, and a drive was found at the incorrect SCSI ID, and unidentified drives were found.	
07	5C	Online/rebuild and hot spare/standby hot-spare drives are not responding, a drive was found at the incorrect SCSI ID, and unidentified drives were found.	
07	6C	Online/rebuild and ready/standby drives are not responding, a drive was found at the incorrect SCSI ID, and unidentified drives were found.	
07	7C	Online/rebuild, ready/standby, and hot spare/standby hot-spare drives are not responding, a drive was found at the incorrect SCSI ID, and unidentified drives were found.	<p>To correct the problem:</p> <ol style="list-style-type: none"> To keep the previous configuration in the controller, replace the physical drives and cable connections that were switched or moved; then, press F4 to retry. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. <p>To exit without making changes, press F10.</p>
07	18	Online/rebuild and hot spare/standby hot-spare drives are not responding.	
07	28	Online/rebuild and ready/standby drives are not responding.	
07	38	Online/rebuild, ready/standby, and hot spare/standby hot-spare drives are not responding.	
07	48	Online/rebuild drives are not responding, and unidentified drives were found.	
07	58	Online/rebuild and hot spare/standby hot-spare drives are not responding, and unidentified drives were found.	
07	68	Online/rebuild and ready/standby drives are not responding, and unidentified drives were found.	
07	78	Online/rebuild, ready/standby, and hot spare/standby hot-spare drives are not responding, and unidentified drives were found.	<p>No action is required. Press F10 to exit without making any changes.</p>
09	00	No error occurred.	

BCS	ECS	Explanation	Action
09	10	Hot spare/standby hot-spare drives are not responding.	To correct the problem: <ol style="list-style-type: none"> To keep the previous configuration in the controller, replace the physical drives and cable connections that were switched or moved; then, press F4 to retry. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. To exit without making changes, press F10.
09	20	Ready/standby drives are not responding.	
09	30	Hot spare/standby hot-spare and ready/standby drives are not responding.	
0F	00	No error occurred.	No action is required. Press F10 to exit without making any changes.
0F	10	Hot spare/standby hot-spare drives are not responding.	To correct the problem: <ol style="list-style-type: none"> To keep the previous configuration in the controller, replace the physical drives and cable connections that were switched or moved; then, press F4 to retry. If all the physical drives are present and connected correctly, one or more of the drives might be defective. Identify and replace the defective drives; then, press F5 to accept the changes. To exit without making changes, press F10.
0F	20	Ready/standby drives are not responding.	
0F	30	Hot spare/standby hot-spare and ready/standby drives are not responding.	

Recovering from problems starting the ServeRAID Manager

Problem	Explanation	Action
The ServeRAID Manager program hangs on the splash screen.	You might be using an old version of the ServeRAID device driver.	Upgrade the ServeRAID device driver to the latest version. See Chapter 5, "Installing ServeRAID device drivers" on page 49 for more information.
When starting the ServeRAID Manager, the following error message is displayed: Unable to find load file RAIDMAN	The ServeRAID Manager program was not installed to the root directory of the SYS volume.	Reinstall the ServeRAID Manager. If the installation is completed properly, there will be a directory called RAIDMAN under the root directory of the SYS volume.
When starting the ServeRAID Manager, the following error message is displayed: -autounload is an invalid parameter	You are using an old version of the Novell Java Virtual machine (JVM).	Download and install the latest JVM from the Novell Web site: http://developer.novell.com/ndk/download.htm
When starting the ServeRAID Manager, the following error message is displayed: ERROR: Unable to find Java	The Novell Java Virtual machine (JVM) is not installed on your server.	Download and install the latest JVM from the Novell Web site: http://developer.novell.com/ndk/download.htm

Problem	Explanation	Action
<p>The ServeRAID Manager program fails to start, and the following error message is displayed:</p> <pre>Can't find class com.ibm.sysmgmt.raidmgr.mgtGUI. Launch</pre>	<p>Your TCP/IP hosts file is not configured for the local server hostname.</p>	<p>Configure your TCP/IP hosts file for the local server hostname.</p> <ol style="list-style-type: none"> 1. Open the <code>/etc/hosts</code> file. 2. If TCP/IP networking is configured, complete the following steps: <ol style="list-style-type: none"> a. If the hostname of the server is identified on the line starting with <code>127.0.0.1</code>, remove the hostname from this line. b. On a new line, type the IP address of the server. c. Press the Tab key to the second column and type the fully qualified hostname. d. Press the Tab key to the third column and type the nickname for the server. <p>Note: The following is an example of a completed line:</p> <pre>1.1.1.1 matrix.localdomain matrix</pre> <p>where <code>1.1.1.1</code> is the IP address of the server and <code>matrix</code> is the hostname of the server.</p> 3. If TCP/IP networking is not configured, type the server name in the third column of the line that starts with <code>127.0.0.1</code>. <p>Note: The following is an example of a completed line:</p> <pre>127.0.0.1 localhost matrix</pre> <p>where <code>matrix</code> is the server name.</p> 4. Restart the server for these changes to take effect.

Recovering from an incomplete format of a physical drive

During formatting of a physical drive, if the format process is stopped by a system reset, system shutdown, power outage, or by some other means, the physical drive becomes inoperable.

Complete the following steps to enable the physical drive to communicate with the ServeRAID controller again:

1. Note the channel of the ServeRAID controller to which the physical drive is connected.
2. Note the SCSI ID of the physical drive.
3. Use the **ipssend format** function to restart the format of the physical drive. The syntax is: **ipssend format** *controller channel sid*
where:
 - *controller* is the ServeRAID controller number (1–12)
 - *channel* is the channel number for the device (1–4)
 - *sid* is the SCSI ID for the device (0–15)

After the format process is complete, the ServeRAID controller will be able to recognize the drive again.

Rebuilding a defunct drive

A physical drive is marked defunct when there is a loss of communication between the controller and the physical drive. This can be caused by any of the following:

- An improperly connected cable, physical drive, or controller
- Loss of power to a drive
- An improperly assembled SCSI channel in an unsupported configuration
- A defective cable, backplane, physical drive, or controller
- Connecting unsupported SCSI devices (such as tape drives or CD-ROM drives) to the same SCSI channel used for an array

In each case, after the communication problem is resolved, a rebuild operation is required to reconstruct the data for the device in its disk array. The ServeRAID controllers can reconstruct RAID level-1, level-1E, level-5, level-5E, level-10, level-1E0, and level-50 logical drives. They cannot, however, reconstruct data stored in RAID level-0 logical drives because RAID level-0 is not redundant. If an array contains only RAID level-0 logical drives, the logical drives in the array are marked offline and the logical drives contain damaged data. You cannot rebuild the logical drives. You must correct the cause of the failure or replace the physical drives; then, you must restore your data.

To prevent data-integrity problems, the ServeRAID controllers set the RAID level-0 logical drives in the affected array to blocked during the rebuild operation for RAID level-1 or RAID level-5. After the rebuild operation is completed, you can unblock the RAID level-0 logical drives and access them once again. Remember, however, that the RAID level-0 logical drives contain damaged data.

Note: For logical drives in an IBM ServeRAID Cluster Solution:

- Because shared logical drives can have *only* one logical drive for each array, blocking a RAID level-0 logical drive during a rebuild operation does *not* apply to shared logical drives.
- Because non-shared logical drives can have *more* than one logical drive for each array, blocking a RAID level-0 logical drive during a rebuild operation *does* apply to non-shared logical drives.

Recovering from defunct drives

If the defunct drives are not part of an array, contact your IBM service representative.

If a physical drive fails in an array or multiple physical drives fail in separate arrays (one physical drive per array), complete the following steps:

1. Replace each defunct physical drive. The ServeRAID controller starts the rebuild operation when it detects the removal and reinsertion of a drive that is part of an array.

Note: (For a configuration that contains a hot-spare drive) If you replace a failed physical drive, it is not necessary to position the new physical drive on the same SCSI channel and SCSI ID as the original hot-spare drive. The replacement physical drive is automatically incorporated into the configuration as a hot-spare drive. Here is an example of how this works:

- a. The original configuration consists of a RAID level-5 logical drive composed of four physical drives. The physical drives are connected to SCSI channel 1; they are assigned SCSI IDs 0, 1, 2, and 3. SCSI ID 3 is a hot-spare drive.
 - b. The physical drive at Channel 1, SCSI ID 2, fails; the logical drive enters the critical state.
 - c. The hot-spare drive at Channel 1, SCSI ID 3, is rebuilt into the array.
 - d. You remove the failed physical drive at Channel 1, SCSI ID 2, and replace it with a new physical drive. The new physical drive at Channel 1, SCSI ID 2, is automatically assigned to be a hot-spare drive.
2. If a rebuild operation is in progress, wait until the rebuild is complete. Otherwise, go to step 3.

Note: If you are replacing multiple defunct drives, you must wait for each rebuild operation to complete before starting subsequent rebuild operations.

3. Verify the cables, physical drives, and controllers are installed properly.
4. Attempt to rebuild the defunct physical drive by performing a hot-swap rebuild. See “Rebuilding a hot-swap drive” for instructions.
5. If the hot-swap rebuild fails, contact your IBM service representative.

Rebuilding a hot-swap drive

A hot-swap rebuild refers to a rebuild operation that is started by the ServeRAID controller when it detects that a drive that is part of an array and in the defunct state has been removed and reinserted on the SCSI cable or backplane. The reinsertion of the physical drive, whether it is the same drive or a new drive, will trigger the ServeRAID controller to start the rebuild operation. During the rebuild operation, the drive being rebuilt is in the rebuild state, and the logical drive remains critical until the rebuild operation has been successfully completed.

On IBM servers, when a hot-spare drive is available, the rebuild operation begins automatically without the need to replace the failed drive. If more than one drive fails within the same array, no rebuild takes place. If multiple drives fail in separate arrays (one physical drive per array), the controller initiates a rebuild operation for the logical drives within the array containing the first failed physical drive. This rebuild operation is performed on the *first* hot-spare drive of sufficient size to become a valid member of the array.

Complete the following steps to start a hot-swap rebuild:

1. Without removing the drive completely, gently remove the physical drive from the server, using the handle of the hot-swap tray. If necessary, see the documentation that comes with your server for information about removing a physical drive.

Attention

When power is removed from a hot-swap drive, the drive immediately parks the heads, locks the actuator in the “landing zone,” and begins spinning down. However, the spinning down of the disk might require up to 20 seconds after power is removed. Do not move the drive while it is spinning down. Moving the drive while it is spinning down might damage the drive.

2. Wait 20 seconds to allow the physical drive to completely stop spinning.
3. If you are certain there is nothing wrong with the physical drive you removed, gently reinstall the drive into the server. Make sure the drive is completely installed in the backplane connector.

Otherwise, replace the physical drive with a new drive that is the same size (or larger) and continue with the rebuild operation.

Notes:

- a. If multiple drives fail in separate arrays (one physical drive per array), replace each defunct physical drive. If multiple physical drives fail at the same time within the *same* array, contact your IBM service representative.
- b. Although it is possible to rebuild a defunct physical drive to an online physical drive that is defective, avoid doing so.

Recovering from multiple physical drive failures (Windows only)

Important:

- There is no guarantee that this procedure will recover data.
- This procedure requires a ServeRAID-3 or ServeRAID-4 controller with BIOS and firmware at version 4.x or later installed *prior* to the physical drive failures.
- Repeat this procedure for *each* array that contains multiple physical drives marked defunct.

The ServeRAID controller is designed to tolerate a *single* physical drive failure in an array. Although there is no guarantee that intact data can be recovered after a *multiple* physical drive failure in an array, the following procedure offers the possibility of a successful recovery in the event that multiple physical drives are marked defunct within the same array.

You will need the following:

- An *IBM ServeRAID Support CD*, version 4.80 or later.
- A diskette containing the IPSSSEND command-line program. This can be either downloaded from the IBM Web site or created using the *IBM ServeRAID Support CD*.
- A version of DUMPLOG and CLEARLOG appropriate for your operating system. You can download both programs from the IBM Support Web site at <http://www.ibm.com/pc/support>

Notes:

1. If you have downloaded a newer version of the *IBM ServeRAID Support CD*, *do not* upgrade the BIOS and firmware until you have completed this procedure.
2. The following procedures rely upon logging functions introduced in version 4.0 of the *IBM ServeRAID Support CD*. The ServeRAID controller must have had BIOS and firmware version 4.x or later installed *prior* to the multiple physical drive failure.

This procedure involves the following steps:

1. Capturing the ServeRAID logs
2. Isolating and removing the failed physical drive
3. Checking the hardware connections
4. Setting defunct drives to the online state
5. Accessing the critical logical drives
6. Finishing the procedure

Capturing the ServeRAID logs

Complete the following steps to capture the ServeRAID logs:

1. Run DUMPLOG.BAT to capture the ServeRAID logs. Do one of the following:
 - If the operating system is located on the failed logical drive, complete the following steps:
 - a. Copy the DUMPLOG.BAT and CLEARLOG.BAT files to the root of the ServeRAID diskette.
 - b. Start the server from the ServeRAID command-line diskette.
 - c. At the prompt, type the following:

```
DUMPLOG filename controller
```

where *filename* is the name of the text file and *controller* is the ServeRAID controller number (1-12)
 - If the operating system is accessible, complete the following tasks:
 - a. Copy or extract the DUMPLOG utility appropriate for your operating system to a local directory or folder.
 - b. Run the DUMPLOG command appropriate for the operating system and save the output to a text file.
2. Send the logs to your IBM service representative for root-cause analysis. The logs provide the best evidence for determining the cause of the failure.

Isolating and removing the failed physical drive

To use ServeRAID Manager to determine the order in which drives were marked defunct, complete the following steps:

1. Start ServeRAID Manager in startable-CD mode.
2. In the ServeRAID Manager tree, right-click **Local system**.
3. Click **Save printable configuration and event logs**; then, press Enter. A window opens, listing the name and location of the log file.
4. Click **OK**.
5. Open the log file in a text editor. The ServeRAID defunct drive event log lists all physical drives marked defunct; the most recent failure is shown at the bottom of the list.
6. Review the list to determine which physical drive failed first. If you cannot determine which drive failed first, go to step 7 on page 162 of "Accessing the critical logical drives."

Notes:

- a. The ServeRAID defunct drive event log *might* contain entries from earlier incidents of defunct drives. Review the list of defunct drives carefully, and use the date and time stamps to identify the first drives associated with *this* incident.

- b. In certain circumstances, the ServeRAID defunct drive event log does not list the drives in the exact order that the drives failed. For example, when an array spans multiple ServeRAID channels, the ServeRAID controller issues parallel I/O requests to devices on each channel. In the event of a catastrophic failure, physical drives might be marked defunct at the same time.
7. Remove the first physical drive marked defunct from the backplane or disconnect the SCSI cable from the drive.
8. Exit ServeRAID Manager; then, shut down the server.

Checking the hardware connections

While the server is turned off, complete the following tasks:

1. Reseat the ServeRAID controllers.
2. Reseat the SCSI cables and the disks against the backplanes.
3. Reseat the power cables to the backplane and SCSI backplane repeater options, if they are present.

As you are reseating the components, visually inspect each piece for bent pins, nicks, crimps, pinches, or other signs of damage. Take extra time to ensure that each component snaps or clicks into place properly.

Setting defunct drives to the online state

Complete the following steps to set the defunct drives to the online state:

1. Start the server.
2. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
3. Use ServeRAID Manager to delete all hot-spare and standby-hot-spare drives. This will prevent a rebuild operation from starting.
4. Set each defunct physical drive in the failed array to the online state. The failed logical drives should change to a critical state. If there are problems bringing physical drives online, or if a physical drive initially goes online and then fails to a defunct state soon after, see “Troubleshooting” on page 162. The logical drives must be in a critical state before you proceed.

Accessing the critical logical drives

Complete the following steps to attempt to access the critical logical drives:

1. If you are still in ServeRAID Manager, exit and restart the server.
2. Attempt to start the operating system. If you are prompted to perform any file-system integrity tests, skip the tests.
3. If the operating system starts, run the `IPSSSEND getbst` command on each logical drive. This will determine if the bad stripe table has incremented on a logical drive. If there are one or more bad stripes, data is lost or damaged.
4. Run a read-only, file-system integrity check on each logical drive.
5. Using application-specific tools, run more intensive integrity tests on each logical drive.
6. If all tests pass, you can assume that the data is good. Go to “Finishing the procedure” on page 162. Otherwise, weigh the results of the file-integrity tests and determine how best to proceed. Your options include the following:
 - Use a recent backup to restore damaged files.
 - Use a recent backup to restore damaged files; schedule a planned outage to rebuild the data at a later date.

- Restore or rebuild the data.
7. Restore or rebuild the missing data on each critical logical drive if any of the following problems persists:
 - The critical logical drive remains inaccessible.
 - Data errors are found on the critical logical drives.
 - The operating system continuously fails to start properly.
 - Partition information on the critical logical drives is unknown.

Finishing the procedure

Complete the following steps:

1. Initiate a backup of the data.
2. After the backup is completed, replace the physical drive that was removed in step 7 on page 161. The new physical drive must be equal to or greater in size than the original drive. An auto-rebuild operation will start.
3. If necessary, redefine the hot-spare drives.
4. Using DUMPLOG, capture another set of ServeRAID logs.
5. Clear the ServeRAID logs using the following CLEARLOG.BAT command available on the DUMPLOG Web site:

```
CLEARLOG controller
```

where *controller* is the ServeRAID controller number (1-12).

6. If a case was opened with your IBM service representative for this problem, complete steps 7 through 9; otherwise, you have completed the recovery process.
7. Using DUMPLOG, capture the ServeRAID logs after two to three days of normal activity.
8. E-mail the ServeRAID logs to your IBM service representative.
9. If IBM determines that the ServeRAID controller and SCSI bus activities are not operating properly, your IBM service representative will provide an action plan. Follow the action plan, and repeat steps 7 and 8 until the system is running normally.

Troubleshooting

If you continue to experience problems, review the following information. It might help you identify the configuration or hardware problem.

Poor signal quality across the SCSI bus

The most common cause of multiple physical drive failures is poor signal quality across the SCSI bus. As the SCSI protocol tries to recover, the overhead increases. As the system becomes busier and demand for data increases, the corrective actions of the SCSI protocol increase, and the SCSI bus moves toward saturation. This overhead will eventually limit the normal device communication bandwidth. If left unchecked, one or more SCSI physical drives might not respond to the ServeRAID controller in a timely way, which will result in the ServeRAID controller marking the physical drives defunct.

Poor signal quality problems can be caused by any of the following:

- Improper installation of the ServeRAID controller in a PCI slot
- Poor cable connections
- Poor seating of hot-swap drives against the SCSI backplane
- Improper installation or seating of backplane repeaters

- Improper SCSI bus termination

Isolating hardware problems

You can use the following techniques to isolate most hardware problems:

- Check error codes within the ServeRAID Manager when a physical drive fails to respond to a command. Research these codes in the *Hardware Maintenance Manual and Troubleshooting Guide* for your server.
- In non-hot swap systems, make sure the physical drives are properly attached to the cable connectors. Start with the connector closest to the SCSI terminator and work your way forward to the connector closest to the controller. Examine each SCSI device and ensure that it has the proper jumper settings.
- While the server is turned off, reseal the ServeRAID controller in its PCI slot and all cables and disk devices on the SCSI bus.
- Examine the cables for bent or missing pins, nicks, crimps, pinches, or over-stretching.
- Temporarily attach the physical drives to an integrated SCSI controller, if available. Start the BIOS. As the BIOS POST runs, review the status of the physical drives and the negotiated data rates. Determine if it is correct.

From the BIOS, choose an option which will list all the devices attached to the controller. Select one of the physical drives and initiate a media test. This will test the device and the entire SCSI bus. If you see errors on the integrated SCSI controller, try to determine if it is the physical drive or the cable by initiating a media test on other physical drives. Test both online and defunct physical drives to determine if the test results are consistent with the drive states on the ServeRAID controller. You can also move hot-swap physical drives to a different position on the backplane and retest to see if the results change.

If the problem persists, swap out the SCSI cable and run a media test again on the physical drives. If the physical drives pass the test, the previous cable is bad. This is a valuable technique for isolating a failing component in the SCSI path.

Note: Depending on the rate at which it negotiates data with low-voltage differential (LVD) SCSI devices, an integrated controller might produce different results than the ServeRAID controller.

- Use the system diagnostics to test the ServeRAID subsystem. Press F2 to start diagnostics. If the subsystem fails the test, disconnect the physical drives from the ServeRAID controller; then, reset the controller to the factory-default settings. Run the diagnostic tests again. If the subsystem passes the diagnostics test, then attach the disks to the ServeRAID controller, one channel at a time, and run the tests again to isolate the channel of the failing component. If the controller continues to fail diagnostic tests, call your IBM service representative for further assistance.

Note: Be sure to use the most recent diagnostic tests available for the server.

- Disconnect the first physical drive marked defunct from the cable or backplane. Restore the ServeRAID controller to the factory-default setting. Attempt to import the RAID configuration from the physical drives. Depending on how the failure occurred, this technique might have mixed results. There is a reasonable chance that all physical drives will return to an online state, except for the physical drive that is disconnected.
- Move the ServeRAID controller into a different PCI slot or PCI bus and retest.

Notes:

1. When attaching an LVD ServeRAID controller to storage enclosures, set the data rate for the channel to the data rate supported by the enclosure.

2. Mixing LVD SCSI devices with single-ended SCSI devices on the same SCSI bus will switch all devices on the channel to single-ended mode and data rates.
- Open a case with your IBM service representative. Submit all ServeRAID logs captured on the system for interpretation to isolate a failing component.

Locating the startup device (SCO OpenServer only)

After installing a ServeRAID controller, SCO OpenServer might fail to find the startup (boot) device.

This problem occurs when your server locates a startup device before coming to the ServeRAID controller on which OpenServer is installed. To solve this problem, consult the documentation that came with your server to determine the PCI slot scan order; then, specify the startup device.

Complete the following steps to specify the startup device:

1. Restart the server.
2. From the prompt, type the following and press Enter:

```
boot: defbootstr Sdsk=ips(x,0,0,0)
```

where *x* is the number of startup devices installed before the ServeRAID controller on which OpenServer is installed.

Solving problems in a failover environment

Use these procedures to recover from problems in a failover environment. If you still have problems after following these procedures, contact your IBM service representative for further information. Also, you can find hints and tips to help you solve problems on the IBM Support Web site. See “Downloadable files from the World Wide Web” on page 141 for additional information.

Recovering from a failure in a failover environment

In a failover environment, when the ServeRAID device driver is unable to send a command to the active controller and the active controller does not respond to a reset command, the device driver attempts to failover to the passive controller.

Note: Loose cables or defective physical drives will not cause a failover to occur.

Replacing a controller of a failover pair in a non-hot-plug PCI slot


Important

Before replacing the failed controller, ensure that you have the latest device drivers, BIOS, and firmware code installed in your server. Follow the instructions in Chapter 17, “Upgrading a ServeRAID controller” on page 143.

If a failed controller is not in a hot-plug PCI slot, complete the following steps:

1. Shut down the server.
2. Replace the failed controller.

Note: Do not attach the SCSI cables to the new controller.

3. Insert the *IBM ServeRAID Support CD* into the CD-ROM drive; then, turn on the server. The ServeRAID Manager program starts.
4. Select the controller that you just inserted, and click **Actions** → **Restore to factory-default settings**.
5. If a confirmation window opens, click **Yes**. When the operation is complete, a message appears at the bottom of the window indicating that the ServeRAID Manager has successfully restored the configuration to the factory-default settings.
6. Configure the new controller for failover. Click  (Configure for clustering) on the toolbar. The “Configure controller for clustering” window opens.

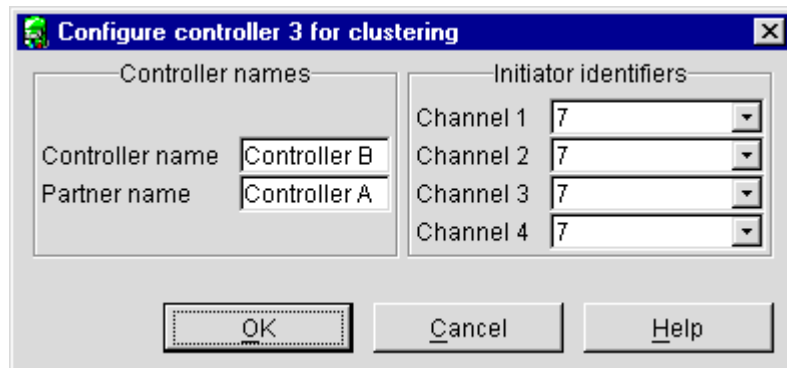


Figure 45. “Configure controller for clustering” window

7. Type the controller name, partner name, and SCSI initiator IDs that you used for the controller you are replacing.
8. Click **OK**.
9. Shut down the server.

Important

When connecting the cables, you must connect the same channel connectors on both ServeRAID controllers to the enclosure. For example, if you connect the cable from Channel 1 on the first ServeRAID controller to the enclosure, you must connect the cable from Channel 1 on the second ServeRAID controller to the enclosure.

10. Connect the enclosure to the new ServeRAID controller.
11. Remove the *IBM ServeRAID Support CD* from the CD-ROM drive; then, turn on the server.
12. Start the ServeRAID Manager program that is installed on the server; then, confirm that the ServeRAID controllers are correctly configured for failover (see Figure 30 on page 63).

Replacing a controller of a failover pair in a hot-plug PCI slot

If the failed controller is in a hot-plug slot, see the documentation that comes with the server for instructions for replacing the controller.

Note: Windows 2000 does not support the hot-replace feature. For more information, see “Replacing a controller of a failover pair in a non-hot-plug PCI slot” on page 164.

For Windows NT 4.0, use the following software to replace the controller. Follow the on-screen directions:

- IBM Netfinity PCI Hot Plug for Windows NT 4.0 Package, version 4.1 or later
- (For the ServeRAID-4M, ServeRAID-4Mx, ServeRAID-4L, and ServeRAID-4Lx controllers only) IBM PCI Hot Plug Adapter Update, version 1.0, for the IBM Netfinity PCI Hot Plug for Windows NT 4.0
- IBM ServeRAID Manager program
- IBM ServeRAID Hot Replace Wizard

Recovering from a failed physical drive in a RAID level-5E environment

If a RAID level-5E logical drive undergoes compression as the result of a failed physical drive, the failed drive will be marked defunct hot spare (DHS). Replace the defunct physical drive or remove the defunct drive from the enclosure as soon as possible. If a DHS drive is present, the RAID level-5E logical drive might not failover.

Recovering from a power failure during a failover

If a power failure occurs during a failover, the two controllers in the active-passive pair might have the following problems:

- Some logical drives are configured on one controller and some logical drives are configured on the other controller.
- A logical drive does not appear on either controller.

Complete the following steps to recover from a power failure:

1. Run **ipssend merge** for every merge-group number configured on the active controller.

Note: If **ipssend merge** fails, run **ipssend merge partner** for every merge-group number configured on the active controller.

2. Run **ipssend unmerge** for every merge-group number configured on the passive controller.
3. Shut down and restart the server. Windows 2000 and Windows NT 4.0 pairs the controllers again.

Troubleshooting an IBM ServeRAID Cluster Solution

There is the possibility that one of the servers, one of the ServeRAID controllers, or one of the hard disk drives in a cluster might fail. This section presents procedures you can take to recover from these potential problems. If you still have problems after following these procedures, contact your IBM service representative for further information. Also, you can find hints and tips to help you solve problems on the IBM Support Web site. See "Downloadable files from the World Wide Web" on page 141 for additional information.

Recovering from a failed ServeRAID server

When replacing a failed server in a high-availability configuration, you might not need to replace the ServeRAID controller. However, if you replace your ServeRAID controller, you must reconfigure the controller after installing your new server.

Important

The following procedure requires specific configuration settings for the ServeRAID controller. If the server and controller that are being replaced are functional, you can obtain these settings from the controller. However, if the controller or the server is not functional, you will need a record of the settings, such as one created when the controller was previously configured. If you are replacing your ServeRAID controller at the same time as your server, you *must* have correct configuration information to complete this procedure.

Complete the following steps to recover from a failed server:

1. Shut down the failed server.
2. Remove all local physical drives from the failed server.
As you remove your physical drives, be sure to note the bay in which each drive was installed. If you are replacing your failed server with an identical server, you can reinstall the drives in an identical configuration and get your server up and running quickly.
3. If the ServeRAID controller is functional, remove it from the failed server. As you remove the controller from the failed server, be sure to note the following:
 - Which SCSI cables are connected to the SCSI channel connectors on the controller
 - Which PCI slot has the controller installed
4. Install all the local physical drives into the new server, using the location information you recorded in step 2.
For information on how to install a physical drive, see the documentation that comes with your server. If you are replacing the failed server with an identical server, install each physical drive in the same bay as the one it was removed from in the failed server.
5. If the ServeRAID controller in the failed server is *not functional*, or if you are not sure, continue with “Recovering from a failed ServeRAID controller”. Otherwise, perform the following steps with the functional ServeRAID controller:
 - a. Install the controller in the new server.
 - b. Reinstall the cables as they were in the failed server.
 - c. Start the server.

Recovering from a failed ServeRAID controller

You must have the following configuration information to configure your new ServeRAID controller:

- **SCSI initiator IDs**

The SCSI initiator IDs for a non-shared SCSI channel are set to 7. For shared SCSI channels, the SCSI initiator IDs must be 7 or 6; they must be different from the SCSI initiator IDs for the corresponding SCSI channels of the cluster partner controller. Therefore, if you can obtain the SCSI initiator IDs for the corresponding cluster partner system, you know the correct SCSI initiator IDs for this system. For example, if the cluster partner system-shared SCSI initiator IDs were set to 7, the controller you are replacing would need to have its SCSI initiator IDs set to 6 for the shared channels.

- **Controller and partner name**

You can also determine the names for the controller being replaced by reading the settings from the cluster partner system.

- **Stripe-unit size**

The stripe-unit size *must* be the same on both controllers in a high-availability cluster.

- **Unattended mode setting**

This setting is configured automatically as Enabled when a controller is set up for clustering.


If the ServeRAID controller you are replacing *is* functional, you can obtain the above configuration information by starting your server with the *IBM ServeRAID Support CD* in the CD-ROM drive and using the ServeRAID Manager program.

Note: The configuration information is also available in the printable configuration file you might have saved when configuring the ServeRAID controllers for clustering.

If the ServeRAID controller is *not* functional, you will need to refer to a record of the settings that was made when the controller was previously configured. If you do not have a record of the configuration information, see “Obtaining the current configuration information” for information that might help you to assign the proper values.

Obtaining the current configuration information

To obtain the SCSI initiator IDs, controller name, partner name, and stripe-unit size from the corresponding cluster partner controller, complete the following steps:

1. Click **Start** → **ServeRAID Manager**.
or
Start the cluster partner system with the *IBM ServeRAID Support CD* in the CD-ROM drive. The ServeRAID Manager program starts.
2. In the ServeRAID Manager tree, click the cluster partner controller.
3. Click  (Configure for clustering) on the toolbar. The “Configure controller for clustering” window opens.

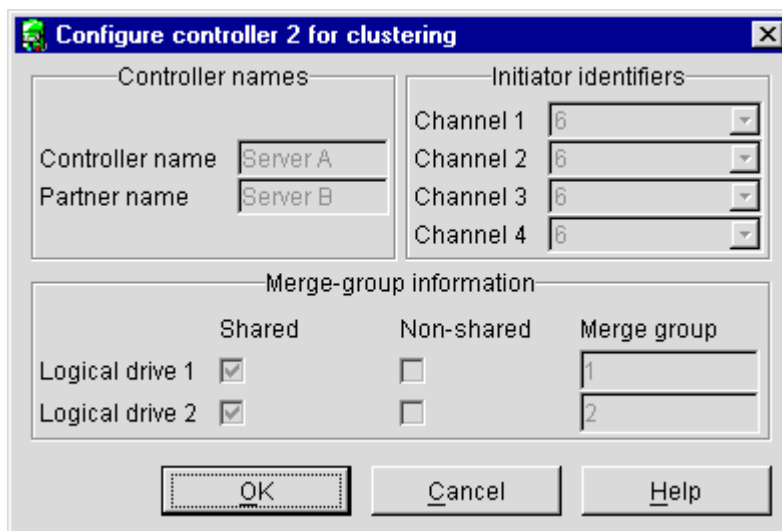


Figure 46. “Configure controller for clustering” window

4. Note the settings in the fields.
5. To determine stripe-unit size, refer to the information displayed in the right pane of ServeRAID Manager.

Replacing a ServeRAID controller

Complete the following steps to replace a failed ServeRAID controller in your high-availability configuration:

1. Shut down the server.
2. Note which SCSI cables are connected to which SCSI channel connectors on the controller.
3. Note which PCI slot has the controller installed.
4. Remove the failed ServeRAID controller.


For instructions on how to remove and install the ServeRAID controller, see the installation guide that came with your ServeRAID controller.

5. Install the new ServeRAID controller. Be sure to install the controller in the same PCI slot from which you removed the failed ServeRAID controller.

Important

- Do *not* reconnect the SCSI channel cables to the controller at this time.
- You must ensure that you have the same level of ServeRAID BIOS and firmware on both controllers in the cluster.

The software is available on the IBM Support Web site. See Chapter 16, “Obtaining ServeRAID updates” on page 141 for additional information.

6. Start the system with the *IBM ServeRAID Support CD* (version 4.0, or later) in the CD-ROM drive. The ServeRAID Manager program starts.
7. In the ServeRAID Manager tree, click the new controller.
8. Click **Actions** → **Restore to factory-default settings**. The ServeRAID Manager program initializes the controller configuration.
9. With the new controller still selected in the tree, click  (Configure for clustering) on the toolbar. The “Configure controller for clustering” window opens.

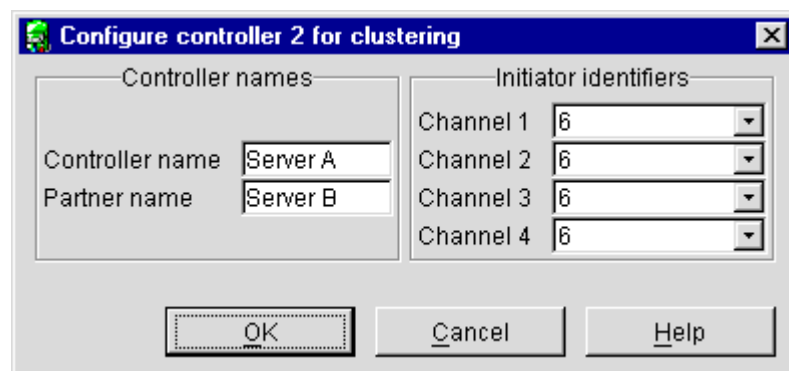


Figure 47. “Configure controller for clustering” window

10. Using the settings that were assigned to the previous ServeRAID controller (that is, the controller you are replacing), complete each of the following fields:
 - SCSI initiator IDs
 - Controller name
 - Partner name
11. Click **OK**. The new controller stripe-unit size setting defaults to 8 KB. If you need to change this setting to match the partner controller, go to step 12. Otherwise, go to step 15 on page 170.
12. In the ServeRAID Manager tree, click the new controller.

13. Click **Actions** → **Change stripe-unit size**.
14. Click the new stripe-unit size for your installation.
15. Shut down and turn off the server.
16. Reconnect the SCSI channel cables to the controller.

Note: Be sure to connect the cables to the correct SCSI channels as noted in step 2 on page 169.

17. If the ServeRAID controller being replaced is attached to the server startup disk array or other non-shared disk arrays, start the system with the *IBM ServeRAID Support* CD (version 4.0, or later) in the CD-ROM drive. The ServeRAID Manager program starts.
If the ServeRAID controller being replaced is not attached to any of these items, go to step 21.
18. In the ServeRAID Manager tree, click the new controller.
19. Click **Actions** → **Copy configuration from drives**.
20. Click the merge-group number for the non-shared logical drives (that is, 206 or 207).

Note: The last number in the merge-group number is the shared SCSI initiator ID. That is, if the merge-group number is 206, the SCSI initiator ID is 6.

21. Remove the *IBM ServeRAID Support* CD from the CD-ROM drive.
22. Restart your server.

Note: If the controller you replaced is the startup controller, the system will now start the operating system properly.

Recovering from a failover in a Microsoft Cluster Server server

After a failover occurs in a Microsoft Cluster Server server, the red drive lights in external expansion enclosures might turn on for physical drives that are online. There is no hardware problem; the lights turn off within an hour.

Recovering from a failed physical drive in a RAID level-5E environment

If a RAID level-5E logical drive undergoes compression as the result of a failed physical drive, the failed drive will be marked defunct hot spare (DHS). Replace the defunct physical drive or remove the defunct drive from the enclosure as soon as possible. If a DHS drive is present, the RAID level-5E logical drive might not failover.

Recovering from a failed server in a ServeRAID cluster

Contact IBM technical support for assistance.

Troubleshooting ServeRAID subsystems in a cluster environment

Following is a series of common problems and solutions that can help you troubleshoot your IBM ServeRAID Cluster Solution.

Problem	Action
<p>The ServeRAID Manager program shows physical drives in defunct state.</p>	<ol style="list-style-type: none"> 1. Enable the View shared drives feature in the ServeRAID Manager program. Doing so will display a drive as reserved, instead of defunct, in the following situations: <ul style="list-style-type: none"> • A drive has been moved. • A drive has failed-over to the other server in the cluster. <p>Note: It is normal for drives in the above situations to be displayed as defunct if you have not enabled the View shared drives feature. In this case, the drives shown in the defunct state are not really defective.</p> 2. Check RAID level-1 and RAID level-5 arrays to make sure they are not in critical state. If they are in critical state, replace the failed drive and perform a rebuild operation.
<p>ServeRAID shared logical drives do not failover properly.</p>	<ol style="list-style-type: none"> 1. Ensure that the resource type of each ServeRAID controller shared disk resource is <i>IBM ServeRAID logical disk</i>. If the resource type is shown as “physical drive,” the localquorum option was not specified properly when MSCS under Windows NT 4.0 was installed. To correct this problem, you must reinstall the high-availability cluster solution using Microsoft Windows NT. 2. Ensure that shared SCSI buses on the ServeRAID controller pair are connected in the same way that corresponding SCSI channels are connected. For example, SCSI channel 1 on the controller in the first cluster server is connected to SCSI channel 1 on the controller in the second cluster server, channel 2 is connected to channel 2, and so forth. 3. Ensure that the physical SCSI drives that contain logical drives are all connected to shared SCSI channels. 4. Ensure that there are no more than eight shared logical drives defined per pair of ServeRAID controllers. 5. Make sure each shared logical drive has a unique merge-group number assigned. Shared merge-group numbers <i>must</i> be in the range 1–8. 6. Make sure each ServeRAID controller has been assigned a unique controller name and that each ServeRAID controller has its partner name assigned properly to correspond to the ServeRAID controller in the other cluster server that is attached to the shared SCSI buses. 7. Check for loose shared SCSI bus cables. 8. Ensure that the physical drives that are expected to be moved or to failover show up in a ready or reserved state on the server that is attempting to take control of these drives.

Problem	Action
<p>RAID level-5 logical drives cannot be accessed by the operating system after a failover.</p>	<p>Use the ServeRAID Manager program to check the state of the logical drive to ensure that it is not blocked. Using this program, select the logical drive and look for Blocked state Yes. If the logical drive is blocked, make sure all physical drives that are part of the logical drive are in the online state. If all physical drives are <i>not</i> in the online state, a drive might have failed during one of the following situations:</p> <ul style="list-style-type: none"> • A failover • A resynchronization process after a failover <p>Data integrity cannot be guaranteed in this case and the logical drive has been blocked to prevent the possibility of incorrect data being read from the logical drive.</p> <p>Unblock, reinitialize, and synchronize the logical drive and restore the data from a backup source. Depending on the type of data contained on the logical drive and the availability of a recent backup copy, you can do one of the following:</p> <ul style="list-style-type: none"> • Unblock the drive and continue normal operation. • Replace and rebuild one or more defunct drives. <p>However, if you do not reinitialize, synchronize, and restore the drive, be aware that some data could be lost or damaged.</p>
<p>If one of the cluster servers fails and the surviving server takes over the cluster resources, occasionally one or more of the IP address resources will stay in the online pending state for several minutes after they are moved over to the surviving server. After this, the resource will go to the failed state, and the following error message will be displayed in the surviving server system log (as viewed with the Event viewer).</p> <p>For example, the Windows NT Event Log Message:</p> <pre>Date: ??? Event ID: 1069 Time: ??? Source: ClusSvc User: N/A Type: Error Computer: ??? Category: (4)</pre> <p>Description: Cluster resource 'ip address resource name' failed</p>	<p>Complete the following steps:</p> <ol style="list-style-type: none"> 1. Right-click the IP resource in the Cluster Administrator. 2. From the General page, click Properties. 3. Select Run this resource in a separate Resource Monitor check box. A message appears stating that the resource must be restarted for the change to take effect. <p>Note: Placing IPSHA disk resources into their own Resource Monitor can decrease failover time.</p>

Problem	Action
<p>After one of the cluster servers has been shut down normally and the surviving server takes over the cluster resources, occasionally one or more of the IBM ServeRAID logical drive resources will stay in the online-pending state for several minutes, after they are moved over to the surviving server (when viewed with the Cluster Administrator). After this, the resource will go to the Failed state and the following error message will be displayed in the surviving server system log (as viewed with the Event viewer).</p> <p>For example, the Windows NT Event Log Message:</p> <pre>Date: ??? Event ID: 1069 Time: ??? Source: ClusSvc User: N/A Type: Error Computer: ??? Category: (4)</pre> <p>Description: Cluster resource 'IBM ServeRAID Logical Disk name' failed.</p>	<p>No action is necessary to bring the resource online after the failover. MSCS will bring this resource online on the surviving server within approximately 4 minutes.</p>
<p>If a previous version of IBM ServeRAID Cluster Solution has been uninstalled, a message is incorrectly displayed prompting you to perform an upgrade when you attempt to reinstall the ServeRAID Windows NT Cluster Solution.</p>	<p>You must delete the <i>C3E76E53-F841-11D0-BFA1-08005AB8ED05</i> registry key. Complete the following steps to delete the registry key:</p> <ol style="list-style-type: none"> 1. From the Start menu, click Run. 2. Type: REGEDIT and click OK. The Registry Editor window opens. 3. Select HKEY_CLASSES_ROOT\CLSID and delete <i>C3E76E53-F841-11D0-BFA1-08005AB8ED05</i>. 4. Reinstall the ServeRAID Windows NT Cluster Solution. For instructions, see Chapter 13, "Configuring ServeRAID controllers for clustering" on page 111.
<p>Array identifiers and logical drive numbers might change during a failover condition.</p>	<p>By design, the array identifiers and logical drive numbers might change during a failover condition. Consistency between the merge-group numbers and Windows NT or Windows 2000 permanent (sticky) drive letters is maintained, while the ordering process during a failover condition is controlled by the Microsoft Cluster Server software and the available array identifiers on the surviving server.</p>

Chapter 19. Getting help and technical assistance

If you need help, service, or technical assistance or just want more information about IBM® products, you will find a wide variety of sources available from IBM to assist you. This chapter contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your xSeries or IntelliStation® system, and whom to call for service, if it is necessary.

Before you call

Before you call, make sure that you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system is turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system.
- Go to the IBM Support Web site at <http://www.ibm.com/pc/support/> to check for technical information, hints, tips, and new device drivers.
- Use an IBM discussion forum on the IBM Web site to ask questions.

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the online help or in the publications that are provided with your system and software. The information that comes with your system also describes the diagnostic tests that you can perform. Most xSeries and IntelliStation systems, operating systems, and programs come with information that contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the information for the operating system or program.

Using the documentation

Information about your IBM xSeries or IntelliStation system and preinstalled software, if any, is available in the documentation that comes with your system. That documentation includes printed books, online books, README files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software. IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. To access these pages, go to <http://www.ibm.com/pc/support/> and follow the instructions. Also, you can order publications through the IBM Publications Ordering System at <http://www.elink.ibm.com/public/applications/publications/cgibin/pbi.cgi>.

Getting help and information from the World Wide Web

On the World Wide Web, the IBM Web site has up-to-date information about IBM xSeries and IntelliStation products, services, and support. The address for IBM xSeries information is <http://www.ibm.com/eserver/xseries/>. The address for IBM IntelliStation information is <http://www.ibm.com/pc/intellistation/>.

You can find service information for your IBM products, including supported options, at <http://www.ibm.com/pc/support/>. If you click **Profile** from the support page, you can create a customized support page. The support page has many sources of information and ways for you to solve problems, including:

- Diagnosing problems, using the IBM Online Assistant
- Downloading the latest device drivers and updates for your products
- Viewing Frequently Asked Questions (FAQ)
- Viewing hints and tips to help you solve problems
- Participating in IBM discussion forums
- Setting up e-mail notification of technical updates about your products

Software service and support

Through IBM Support Line, you can get telephone assistance, for a fee, with usage, configuration, and software problems with xSeries servers, IntelliStation workstations, and appliances. For information about which products are supported by Support Line in your country or region, go to <http://www.ibm.com/services/sl/products/>.

For more information about Support Line and other IBM services, go to <http://www.ibm.com/services/>, or go to <http://www.ibm.com/planetwide/> for support telephone numbers.

Hardware service and support

You can receive hardware service through IBM Integrated Technology Services or through your IBM reseller, if your reseller is authorized by IBM to provide warranty service. Go to <http://www.ibm.com/planetwide/> for support telephone numbers.

In the U.S. and Canada, hardware service and support is available 24 hours a day, 7 days a week. In the U.K., these services are available Monday through Friday, from 9 a.m. to 6 p.m.

Part 5. Appendixes

Appendix A. Creating ServeRAID diskettes

Images for the following diskettes are in the \DISKETTE directory of the *IBM ServeRAID Support* CD. Each of the operating-system specific diskettes contains device drivers and the IPSEND utility.

Note: The IPSMON utility is available only on the *IBM ServeRAID Support for Novell NetWare* diskette.

Diskette image	Diskette
biosfw1.img	<i>IBM BIOS and Firmware Update (1 of 3)</i> for the ServeRAID-5i controller
biosfw2.img	<i>IBM BIOS and Firmware Update (2 of 3)</i> for the ServeRAID-4H, ServeRAID-II, ServeRAID on-board, and the ServeRAID controllers
biosfw3.img	<i>IBM BIOS and Firmware Update (3 of 3)</i> for the ServeRAID-4M, ServeRAID-4Mx, ServeRAID-4L, ServeRAID-4Lx, ServeRAID-3H, and ServeRAID-3L controllers
failover.img	<i>IBM ServeRAID Failover Support for Windows NT and Windows 2000</i>
clusnt.img	<i>IBM ServeRAID Cluster Solution for Windows NT and Windows 2000</i>
winsrv.img	<i>IBM ServeRAID Support for Windows 2000 Server</i>
winpro.img	<i>IBM ServeRAID Support for Windows (Professional Editions)</i> for Microsoft Windows XP Professional and Microsoft Windows 2000 Professional
os2.img	<i>IBM ServeRAID Support for OS/2</i>
winnt.img	<i>IBM ServeRAID Support for Windows NT 4.0</i>
netware.img	<i>IBM ServeRAID Support for Novell NetWare</i>
openunix.img	<i>IBM ServeRAID Support for Caldera UnixWare and Open UNIX</i>
openserv.img	<i>IBM ServeRAID Support for SCO OpenServer</i>
redhat1.img	<i>IBM ServeRAID Support for Red Hat Linux (1 of 2)</i> for Red Hat Linux, versions 6.2 and 7.0
redhat2.img	<i>IBM ServeRAID Support for Red Hat Linux (2 of 2)</i> for Red Hat Linux, versions 7.1, 7.2, and 7.3
caldera1.img	<i>IBM ServeRAID Support for Caldera OpenLinux (1 of 2)</i> for Caldera OpenLinux, version 3.1
caldera2.img	<i>IBM ServeRAID Support for Caldera OpenLinux (2 of 2)</i> for Caldera OpenLinux, version 3.1.1
suse.img	<i>IBM ServeRAID Support for SuSE Linux</i>
turbo.img	<i>IBM ServeRAID Support for Turbolinux</i>
dos.img	<i>IBM ServeRAID Support for DOS</i>

Creating diskettes on Windows

Complete the following steps to create a diskette:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Insert a blank diskette into the diskette drive.
3. At the DOS or command prompt, type the following and press Enter:

```
e:\diskette\tools\dsk4w32 e:\diskette\disketteimage a:
```

where

- *e* is the drive letter for the CD-ROM drive.
- *disketteimage* is the name of the diskette image.
- *a* is the drive letter for the diskette drive.

4. Remove the *IBM ServeRAID Support* CD from the CD-ROM drive.
5. Remove the diskette from the diskette drive and label the diskette appropriately.

Creating diskettes on IBM OS/2

Complete the following steps to create a diskette:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Insert a blank diskette into the diskette drive.
3. At the OS/2 command prompt, type the following and Press Enter:

```
e:\diskette\tools\dsk4wrp e:\diskette\disketteimage a:
```

where

- *e* is the drive letter for the CD-ROM drive.
- *disketteimage* is the name of the diskette image.
- *a* is the drive letter for the diskette drive.

4. Remove the *IBM ServeRAID Support* CD from the CD-ROM drive.
5. Remove the diskette from the diskette drive and label the diskette appropriately.

Creating diskettes on Linux or UNIX

Complete the following steps to create a diskette:

1. Insert the *IBM ServeRAID Support* CD into the CD-ROM drive.
2. Insert a blank diskette into the diskette drive.
3. At a command prompt, mount the CD-ROM drive by typing one of the following:

For Linux	<code>mount -t iso9660 /dev/cdromdevicefile /mountpoint</code>
------------------	--

For OpenServer	<code>mount -r -f ISO9660 /dev/cdromdevicefile /mountpoint</code>
-----------------------	---

For UnixWare and Open UNIX	<code>mount -f cdfs /dev/cdromdevicefile /mountpoint</code>
-----------------------------------	---

where *cdromdevicefile* is the specific device file for the CD-ROM block device, and *mountpoint* is the mountpoint of the CD-ROM drive.

4. Press Enter.

5. At the command prompt, type the following:

```
dd if=/mnt/diskette/disketteimage of=/dev/diskettedevicefile bs=32k
```

where

- *disketteimage* is the name of the diskette image.
- *diskettedevicefile* is the specific device file for the diskette block device.

6. Press Enter.
7. Unmount the CD-ROM drive. Type the following and press Enter:

```
umount /mountpoint
```

where *mountpoint* is the mountpoint of the device file used in step 3 on page 180.

8. Remove the *IBM ServeRAID Support* CD from the CD-ROM drive.
9. Remove the diskette from the diskette drive and label the diskette appropriately.

Appendix B. Warranty information

This section contains information about your warranty period and the service and support that are provided by your warranty.

Warranty period

The warranty period varies by machine type and country or region.

Contact your place of purchase for warranty service information. Some IBM Machines are eligible for on-site warranty service depending on the country or region where service is performed.

Prior to on-site warranty service, you are required to go through problem determination with an IBM service specialist call center technician.

A warranty period of 3 years on parts and 1 year on labor means that IBM will provide warranty service without charge for:

1. parts and labor during the first year of the warranty period
2. parts only, on an exchange basis, in the second and third years of the warranty period. IBM will charge you for any labor it provides in performance of the repair or replacement.

The IBM Machine Warranties Web site at http://www.ibm.com/servers/support/machine_warranties/ contains a worldwide overview of the IBM Statement of Limited Warranty for IBM Machines, a glossary of terms used in the Statement of Limited Warranty, Frequently Asked Questions (FAQ), and links to Product Support Web pages. The IBM Statement of Limited Warranty is available from this Web site in 29 languages in Portable Document Format (PDF).

Machine

- IBM ServeRAID-4H Ultra160 SCSI Controller or
- IBM ServeRAID-4Mx Ultra160 SCSI Controller or
- IBM ServeRAID-4Lx Ultra160 SCSI Controller
- IBM ServeRAID-5i Ultra320 SCSI Controller

Country or region	Warranty period	Service delivery method
All countries and regions	3 years	Customer carry-in or mail-in

Problem determination

Prior to on-site warranty service, you are required to go through problem determination with an IBM service specialist call center technician. The service specialist will run diagnostic tests on the hardware and check the software.

Running diagnostics

The IBM service specialist will help you determine whether your equipment is functioning as specified. It might be necessary to isolate the failing xSeries, Netfinity®, or IntelliStation system; IBM component; or both from any active production environment to run diagnostics and perform defect-isolation programs. You are responsible for making the system, IBM component, or both available for running diagnostics and defect-isolation programs.

Checking software

The IBM service specialist will help you ensure that the correct BIOS code, firmware, device drivers, and other supporting IBM software are installed and correctly configured. It might be necessary to manually gather information about the relevant software levels or run IBM-approved utility programs to gather this information. It might be necessary to isolate the failing system from any active production environment to gather this information. You are responsible, with assistance from the service specialist, for gathering this information. The IBM Statement of Limited Warranty does not include on-site assistance with this activity.

Warranty service and support

With the original purchase of an IBM xSeries or IntelliStation system, you have access to extensive service and support. During the IBM Machine warranty period, you may call IBM or your reseller for problem-determination assistance under the terms of the IBM Statement of Limited Warranty.

The following services are available during the warranty period:

- **Problem determination** - Trained personnel are available to assist you with determining if you have a hardware problem and deciding what action is necessary to fix the problem.
- **IBM hardware repair** - If the problem is determined to be caused by IBM hardware under warranty, trained service personnel are available to provide the applicable level of service, either on-site or at an IBM service center as determined by IBM.
- **Engineering Change management** - Occasionally, there might be changes that are required after a product has been shipped from IBM. In those instances, IBM will make Engineering Changes (ECs) available that apply to your hardware.
- **Customer replaceable units (CRUs)** - Some parts of IBM xSeries and IntelliStation systems are designated as customer replaceable units. IBM ships CRUs to you for replacement by you. CRUs include keyboards, monitors, memory, diskette drives, hard disk drives, and mice (this list is not inclusive of all CRUs).

The following items are not covered under warranty service:

- Replacement or use of non-IBM parts. All IBM parts contain a 7-character identification in the format IBM FRU XXXXXXXX.
- Identification of software problem sources.
- Installation of customer replaceable units (CRUs).
- Installation and configuration of BIOS code, firmware, or device drivers that are designated as customer installable.

See the IBM Statement of Limited Warranty for a full explanation of IBM warranty terms. Be sure to retain your proof of purchase to obtain warranty service.

Please have the following information ready when you call:

- The machine type and model of your IBM hardware product (if available)
- Serial numbers of your IBM hardware products
- A description of the problem
- The exact wording of any error messages
- Hardware and software configuration information

International Warranty Service

If you travel with your xSeries or IntelliStation system or relocate it to a country or region where your system is sold and serviced by IBM or IBM resellers authorized to perform warranty service, International Warranty Service (IWS) is available during the warranty period. Eligible IBM systems are identified by their four-digit machine types.

You can obtain IWS through the service delivery method (such as depot, carry-in, or on-site) provided in the servicing country or region. Service methods and procedures vary by country or region, and some service or parts might not be available in all countries and regions. Service centers in certain countries or regions might not be able to service all models of a particular machine type. In addition, some countries or regions might have fees and restrictions that apply at the time of service.

To determine whether your system is eligible for IWS, go to <http://www.ibm.com/pc/support/> and click **Warranty lookup**.

Purchasing additional services

During and after the warranty period, you can purchase additional services, such as support for IBM and non-IBM hardware, operating systems, and application programs; network setup and configuration; upgraded or extended hardware repair services; and custom installations. Service availability and service name might vary by country or region.

For more information about these services, contact your IBM marketing representative.

IBM Statement of Limited Warranty Z125-4753-06 8/2000

Part 1 - General Terms

This Statement of Limited Warranty includes Part 1 - General Terms and Part 2 - Country-unique Terms. The terms of Part 2 replace or modify those of Part 1. The warranties provided by IBM in this Statement of Limited Warranty apply only to Machines you purchase for your use, and not for resale, from IBM or your reseller. The term "Machine" means an IBM machine, its features, conversions, upgrades, elements, or accessories, or any combination of them. The term "Machine" does not include any software programs, whether pre-loaded with the Machine, installed subsequently or otherwise. Unless IBM specifies otherwise, the following warranties apply only in the country where you acquire the Machine. Nothing in this Statement of Limited Warranty affects any statutory rights of consumers that cannot be waived or limited by contract. If you have any questions, contact IBM or your reseller.

The IBM Warranty for Machines: IBM warrants that each Machine 1) is free from defects in materials and workmanship and 2) conforms to IBM's Official Published Specifications ("Specifications"). The warranty period for a Machine is a specified, fixed period commencing on its Date of Installation. The date on your sales receipt is the Date of Installation unless IBM or your reseller informs you otherwise.

If a Machine does not function as warranted during the warranty period, and IBM or your reseller are unable to either 1) make it do so or 2) replace it with one that is at least functionally equivalent, you may return it to your place of purchase and your money will be refunded.

Extent of Warranty: The warranty does not cover the repair or exchange of a Machine resulting from misuse, accident, modification, unsuitable physical or operating environment, improper maintenance by you, or failure caused by a product for which IBM is not responsible. The warranty is voided by removal or alteration of Machine or parts identification labels.

THESE WARRANTIES ARE YOUR EXCLUSIVE WARRANTIES AND REPLACE ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THESE WARRANTIES GIVE YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM JURISDICTION TO JURISDICTION. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF EXPRESS OR IMPLIED WARRANTIES, SO THE ABOVE EXCLUSION OR LIMITATION MAY NOT APPLY TO YOU. IN THAT EVENT, SUCH WARRANTIES ARE LIMITED IN DURATION TO THE WARRANTY PERIOD. NO WARRANTIES APPLY AFTER THAT PERIOD.

Items Not Covered by Warranty: IBM does not warrant uninterrupted or error-free operation of a Machine. Any technical or other support provided for a Machine under warranty, such as assistance via telephone with "how-to" questions and those regarding Machine set-up and installation, will be provided **WITHOUT WARRANTIES OF ANY KIND.**

Warranty Service: To obtain warranty service for a Machine, contact IBM or your reseller. If you do not register your Machine with IBM, you may be required to present proof of purchase.

During the warranty period, IBM or your reseller, if approved by IBM to provide warranty service, provides without charge certain types of repair and exchange service to keep Machines in, or restore them to, conformance with their Specifications. IBM or your reseller will inform you of the available types of service for a Machine based on its country of installation. At its discretion, IBM or your reseller will 1) either repair or exchange the failing Machine and 2) provide the service either at your location or a service center. IBM or your reseller will also manage and install selected engineering changes that apply to the Machine.

Some parts of IBM Machines are designated as Customer Replaceable Units (called "CRUs"), e.g., keyboards, memory, or hard disk drives. IBM ships CRUs to you for replacement by you. You must return all defective CRUs to IBM within 30 days of your receipt of the replacement CRU. You are responsible for downloading designated Machine Code and Licensed Internal Code updates from an IBM Internet Web site or from other electronic media, and following the instructions that IBM provides.

When warranty service involves the exchange of a Machine or part, the item IBM or your reseller replaces becomes its property and the replacement becomes yours. You represent that all removed items are genuine and unaltered. The replacement may not be new, but will be in good working order and at least functionally equivalent to the item replaced. The replacement assumes the warranty service status of the replaced item. Many features, conversions, or upgrades involve the removal of parts and their return to IBM. A part that replaces a removed part will assume the warranty service status of the removed part.

Before IBM or your reseller exchanges a Machine or part, you agree to remove all features, parts, options, alterations, and attachments not under warranty service.

You also agree to

1. ensure that the Machine is free of any legal obligations or restrictions that prevent its exchange;
2. obtain authorization from the owner to have IBM or your reseller service a Machine that you do not own; and
3. where applicable, before service is provided:
 - a. follow the problem determination, problem analysis, and service request procedures that IBM or your reseller provides;
 - b. secure all programs, data, and funds contained in a Machine;
 - c. provide IBM or your reseller with sufficient, free, and safe access to your facilities to permit them to fulfill their obligations; and
 - d. inform IBM or your reseller of changes in a Machine's location.

IBM is responsible for loss of, or damage to, your Machine while it is 1) in IBM's possession or 2) in transit in those cases where IBM is responsible for the transportation charges.

Neither IBM nor your reseller is responsible for any of your confidential, proprietary or personal information contained in a Machine which you return to IBM or your reseller for any reason. You should remove all such information from the Machine prior to its return.

Limitation of Liability: Circumstances may arise where, because of a default on IBM's part or other liability, you are entitled to recover damages from IBM. In each such instance, regardless of the basis on which you are entitled to claim damages from IBM (including fundamental breach, negligence, misrepresentation, or other

contract or tort claim), except for any liability that cannot be waived or limited by applicable laws, IBM is liable for no more than

1. damages for bodily injury (including death) and damage to real property and tangible personal property; and
2. the amount of any other actual direct damages, up to the charges (if recurring, 12 months' charges apply) for the Machine that is subject of the claim. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code.

This limit also applies to IBM's suppliers and your reseller. It is the maximum for which IBM, its suppliers, and your reseller are collectively responsible.

UNDER NO CIRCUMSTANCES IS IBM LIABLE FOR ANY OF THE FOLLOWING: 1) THIRD-PARTY CLAIMS AGAINST YOU FOR DAMAGES (OTHER THAN THOSE UNDER THE FIRST ITEM LISTED ABOVE); 2) LOSS OF, OR DAMAGE TO, YOUR RECORDS OR DATA; OR 3) SPECIAL, INCIDENTAL, OR INDIRECT DAMAGES OR FOR ANY ECONOMIC CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST SAVINGS, EVEN IF IBM, ITS SUPPLIERS OR YOUR RESELLER IS INFORMED OF THEIR POSSIBILITY. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

Governing Law: Both you and IBM consent to the application of the laws of the country in which you acquired the Machine to govern, interpret, and enforce all of your and IBM's rights, duties, and obligations arising from, or relating in any manner to, the subject matter of this Agreement, without regard to conflict of law principles.

Part 2 - Country-unique Terms

AMERICAS

BRAZIL

Governing Law: *The following is added after the first sentence:* Any litigation arising from this Agreement will be settled exclusively by the court of Rio de Janeiro.

NORTH AMERICA

Warranty Service: *The following is added to this Section:* To obtain warranty service from IBM in Canada or the United States, call 1-800-IBM-SERV (426-7378).

CANADA

Governing Law: *The following replaces "laws of the country in which you acquired the Machine" in the first sentence:* laws in the Province of Ontario.

UNITED STATES

Governing Law: *The following replaces "laws of the country in which you acquired the Machine" in the first sentence:* laws of the State of New York.

ASIA PACIFIC

AUSTRALIA

The IBM Warranty for Machines: *The following paragraph is added to this Section:* The warranties specified in this Section are in addition to any rights you may have under the Trade Practices Act 1974 or other similar legislation and are only limited to the extent permitted by the applicable legislation.

Limitation of Liability: *The following is added to this Section:* Where IBM is in breach of a condition or warranty implied by the Trade Practices Act 1974 or other similar legislation, IBM's liability is limited to the repair or replacement of the goods or the supply of equivalent goods. Where that condition or warranty relates to right to sell, quiet possession or clear title, or the goods are of a kind ordinarily acquired for personal, domestic or household use or consumption, then none of the limitations in this paragraph apply.

Governing Law: *The following replaces "laws of the country in which you acquired the Machine" in the first sentence:* laws of the State or Territory.

CAMBODIA, LAOS, AND VIETNAM

Governing Law: *The following replaces "laws of the country in which you acquired the Machine" in the first sentence:* laws of the State of New York.

The following is added to this Section: Disputes and differences arising out of or in connection with this Agreement shall be finally settled by arbitration which shall be held in Singapore in accordance with the rules of the International Chamber of Commerce (ICC). The arbitrator or arbitrators designated in conformity with those rules shall have the power to rule on their own competence and on the validity of the Agreement to submit to arbitration. The arbitration award shall be final and binding for the parties without appeal and the arbitral award shall be in writing and set forth the findings of fact and the conclusions of law.

All proceedings shall be conducted, including all documents presented in such proceedings, in the English language. The number of arbitrators shall be three, with each side to the dispute being entitled to appoint one arbitrator.

The two arbitrators appointed by the parties shall appoint a third arbitrator before proceeding upon the reference. The third arbitrator shall act as chairman of the proceedings. Vacancies in the post of chairman shall be filled by the president of the ICC. Other vacancies shall be filled by the respective nominating party. Proceedings shall continue from the stage they were at when the vacancy occurred.

If one of the parties refuses or otherwise fails to appoint an arbitrator within 30 days of the date the other party appoints its, the first appointed arbitrator shall be the sole arbitrator, provided that the arbitrator was validly and properly appointed.

The English language version of this Agreement prevails over any other language version.

HONG KONG AND MACAU

Governing Law: *The following replaces "laws of the country in which you acquired the Machine" in the first sentence:* laws of Hong Kong Special Administrative Region.

INDIA

Limitation of Liability: *The following replaces items 1 and 2 of this Section:*

1. liability for bodily injury (including death) or damage to real property and tangible personal property will be limited to that caused by IBM's negligence;
2. as to any other actual damage arising in any situation involving nonperformance by IBM pursuant to, or in any way related to the subject of this Statement of Limited Warranty, IBM's liability will be limited to the charge paid by you for the individual Machine that is the subject of the claim.

JAPAN

Governing Law: *The following sentence is added to this Section:* Any doubts concerning this Agreement will be initially resolved between us in good faith and in accordance with the principle of mutual trust.

NEW ZEALAND

The IBM Warranty for Machines: *The following paragraph is added to this Section:* The warranties specified in this Section are in addition to any rights you may have under the Consumer Guarantees Act 1993 or other legislation which cannot be excluded or limited. The Consumer Guarantees Act 1993 will not apply in respect of any goods which IBM provides, if you require the goods for the purposes of a business as defined in that Act.

Limitation of Liability: *The following is added to this Section:* Where Machines are not acquired for the purposes of a business as defined in the Consumer Guarantees Act 1993, the limitations in this Section are subject to the limitations in that Act.

PEOPLE'S REPUBLIC OF CHINA (PRC)

Governing Law: *The following replaces this Section:* Both you and IBM consent to the application of the laws of the State of New York (except when local law requires otherwise) to govern, interpret, and enforce all your and IBM's rights, duties, and obligations arising from, or relating in any manner to, the subject matter of this Agreement, without regard to conflict of law principles.

Any disputes arising from or in connection with this Agreement will first be resolved by friendly negotiations, failing which either of us has the right to submit the dispute to the China International Economic and Trade Arbitration Commission in Beijing, the PRC, for arbitration in accordance with its arbitration rules in force at the time. The arbitration tribunal will consist of three arbitrators. The language to be used therein will be English and Chinese. An arbitral award will be final and binding on all the parties, and will be enforceable under the Convention on the Recognition and Enforcement of Foreign Arbitral Awards (1958).

The arbitration fee will be borne by the losing party unless otherwise determined by the arbitral award.

During the course of arbitration, this Agreement will continue to be performed except for the part which the parties are disputing and which is undergoing arbitration.

EUROPE, MIDDLE EAST, AFRICA (EMEA)

THE FOLLOWING TERMS APPLY TO ALL EMEA COUNTRIES: The terms of this Statement of Limited Warranty apply to Machines purchased from IBM or an IBM reseller.

Warranty Service: If you purchase an IBM Machine in Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland or United Kingdom, you may obtain warranty service for that Machine in any of those countries from either (1) an IBM reseller approved to perform warranty service or (2) from IBM. If you purchase an IBM Personal Computer Machine in Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Kazakhstan, Kirghizia, Federal Republic of Yugoslavia, Former Yugoslav Republic of Macedonia (FYROM), Moldova, Poland, Romania, Russia, Slovak Republic, Slovenia, or Ukraine, you may obtain warranty service for that Machine in any of those countries from either (1) an IBM reseller approved to perform warranty service or (2) from IBM.

If you purchase an IBM Machine in a Middle Eastern or African country, you may obtain warranty service for that Machine from the IBM entity within the country of purchase, if that IBM entity provides warranty service in that country, or from an IBM reseller, approved by IBM to perform warranty service on that Machine in that country. Warranty service in Africa is available within 50 kilometers of an IBM authorized service provider. You are responsible for transportation costs for Machines located outside 50 kilometers of an IBM authorized service provider.

Governing Law: The applicable laws that govern, interpret and enforce rights, duties, and obligations of each of us arising from, or relating in any manner to, the subject matter of this Statement, without regard to conflict of laws principles, as well as Country-unique terms and competent court for this Statement are those of the country in which the warranty service is being provided, except that in 1) Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Hungary, Former Yugoslav Republic of Macedonia, Romania, Slovakia, Slovenia, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan, the laws of Austria apply; 2) Estonia, Latvia, and Lithuania, the laws of Finland apply; 3) Algeria, Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Djibouti, Democratic Republic of Congo, Equatorial Guinea, France, Gabon, Gambia, Guinea, Guinea-Bissau, Ivory Coast, Lebanon, Mali, Mauritania, Morocco, Niger, Senegal, Togo, and Tunisia, this Agreement will be construed and the legal relations between the parties will be determined in accordance with the French laws and all disputes arising out of this Agreement or related to its violation or execution, including summary proceedings, will be settled exclusively by the Commercial Court of Paris; 4) Angola, Bahrain, Botswana, Burundi, Egypt, Eritrea, Ethiopia, Ghana, Jordan, Kenya, Kuwait, Liberia, Malawi, Malta, Mozambique, Nigeria, Oman, Pakistan, Qatar, Rwanda, Sao Tome, Saudi Arabia, Sierra Leone, Somalia, Tanzania, Uganda, United Arab Emirates, United Kingdom, West Bank/Gaza, Yemen, Zambia, and Zimbabwe, this Agreement will be governed by English Law and disputes relating to it will be submitted to the exclusive jurisdiction of the English courts; and 5) in Greece, Israel, Italy, Portugal, and Spain any legal claim arising out of this Statement will be brought before, and finally settled by, the competent court of Athens, Tel Aviv, Milan, Lisbon, and Madrid, respectively.

THE FOLLOWING TERMS APPLY TO THE COUNTRY SPECIFIED:

AUSTRIA AND GERMANY

The IBM Warranty for Machines: *The following replaces the first sentence of the first paragraph of this Section:* The warranty for an IBM Machine covers the functionality of the Machine for its normal use and the Machine's conformity to its Specifications.

The following paragraphs are added to this Section:

The minimum warranty period for Machines is six months. In case IBM or your reseller is unable to repair an IBM Machine, you can alternatively ask for a partial refund as far as justified by the reduced value of the unrepaired Machine or ask for a cancellation of the respective agreement for such Machine and get your money refunded.

Extent of Warranty: *The second paragraph does not apply.*

Warranty Service: *The following is added to this Section:* During the warranty period, transportation for delivery of the failing Machine to IBM will be at IBM's expense.

Limitation of Liability: *The following paragraph is added to this Section:* The limitations and exclusions specified in the Statement of Limited Warranty will not apply to damages caused by IBM with fraud or gross negligence and for express warranty.

The following sentence is added to the end of item 2: IBM's liability under this item is limited to the violation of essential contractual terms in cases of ordinary negligence.

EGYPT

Limitation of Liability: *The following replaces item 2 in this Section:* as to any other actual direct damages, IBM's liability will be limited to the total amount you paid for the Machine that is the subject of the claim. For purposes of this item, the term "Machine" includes Machine Code and Licensed Internal Code.

Applicability of suppliers and resellers (unchanged).

FRANCE

Limitation of Liability: *The following replaces the second sentence of the first paragraph of this Section:*In such instances, regardless of the basis on which you are entitled to claim damages from IBM, IBM is liable for no more than: *(items 1 and 2 unchanged).*

IRELAND

Extent of Warranty: *The following is added to this Section:* Except as expressly provided in these terms and conditions, all statutory conditions, including all warranties implied, but without prejudice to the generality of the foregoing all warranties implied by the Sale of Goods Act 1893 or the Sale of Goods and Supply of Services Act 1980 are hereby excluded.

Limitation of Liability: *The following replaces items one and two of the first paragraph of this Section:*1. death or personal injury or physical damage to your real property solely caused by IBM's negligence; and 2. the amount of any other actual direct damages, up to 125 percent of the charges (if recurring, the 12 months' charges apply) for the Machine that is the subject of the claim or which otherwise gives rise to the claim.

Applicability of suppliers and resellers (unchanged).

The following paragraph is added at the end of this Section: IBM's entire liability and your sole remedy, whether in contract or in tort, in respect of any default shall be limited to damages.

ITALY

Limitation of Liability: *The following replaces the second sentence in the first paragraph:* In each such instance unless otherwise provided by mandatory law, IBM is liable for no more than: 1. *(unchanged)* 2. as to any other actual damage arising in all situations involving nonperformance by IBM pursuant to, or in any way related to the subject matter of this Statement of Warranty, IBM's liability, will be limited to the total amount you paid for the Machine that is the subject of the claim.
Applicability of suppliers and resellers (unchanged).

The following replaces the third paragraph of this Section: Unless otherwise provided by mandatory law, IBM and your reseller are not liable for any of the following: *(items 1 and 2 unchanged)* 3) indirect damages, even if IBM or your reseller is informed of their possibility.

SOUTH AFRICA, NAMIBIA, BOTSWANA, LESOTHO AND SWAZILAND

Limitation of Liability: *The following is added to this Section:* IBM's entire liability to you for actual damages arising in all situations involving nonperformance by IBM in respect of the subject matter of this Statement of Warranty will be limited to the charge paid by you for the individual Machine that is the subject of your claim from IBM.

UNITED KINGDOM

Limitation of Liability: *The following replaces items 1 and 2 of the first paragraph of this Section:*

1. death or personal injury or physical damage to your real property solely caused by IBM's negligence;
2. the amount of any other actual direct damages or loss, up to 125 percent of the charges (if recurring, the 12 months' charges apply) for the Machine that is the subject of the claim or which otherwise gives rise to the claim;

The following item is added to this paragraph: 3. breach of IBM's obligations implied by Section 12 of the Sale of Goods Act 1979 or Section 2 of the Supply of Goods and Services Act 1982.

Applicability of suppliers and resellers (unchanged).

The following is added to the end of this Section: IBM's entire liability and your sole remedy, whether in contract or in tort, in respect of any default shall be limited to damages.

Appendix C. Notices

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Important notes

Processor speeds indicate the internal clock speed of the microprocessor; other factors also affect application performance.

CD-ROM drive speeds list the variable read rate. Actual speeds vary and are often less than the maximum possible.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for approximately 1000 bytes, MB stands for approximately 1 000 000 bytes, and GB stands for approximately 1 000 000 000 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity may vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives available from IBM.

Maximum memory may require replacement of the standard memory with an optional memory module.

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Some software may differ from its retail version (if available), and may not include user manuals or all program functionality.

Electronic emission notices

Federal Communications Commission (FCC) statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Class A emission compliance statement

This Class A digital apparatus complies with Canadian ICES-003.

Avis de conformité à la réglementation d'Industrie Canada

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Australia and New Zealand Class A statement

Attention: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

United Kingdom telecommunications safety requirement

Notice to Customers

This apparatus is approved under approval number NS/G/1234/J/100003 for indirect connection to public telecommunication systems in the United Kingdom.

European Union EMC Directive conformance statement

This product is in conformity with the protection requirements of EU Council Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a nonrecommended modification of the product, including the fitting of non-IBM option cards.

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22/European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Attention: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Taiwanese Class A warning statement

警告使用者：
這是甲類的資訊產品，在
居住的環境中使用時，可
能會造成射頻干擾，在這
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Japanese Voluntary Control Council for Interference (VCCI) statement

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されることがあります。

Glossary

A

array. Two or more physical drives combined for increased capacity, speed, or fault tolerance. Once created, an array is configured as one or more logical drives. The operating system in the server recognizes a logical drive as a single drive.

auto-synchronization. Synchronization on RAID level-5, level-5E, and level-50 drives that is automatically initiated when logical drives are created. This type of synchronization works in the background.

B

battery-backup cache. Buffer storage that protects data during write-back operations; in the event of a power failure, it preserves the data in the controller cache.

BIOS-compatibility mapping. A ServeRAID controller setting with two options: **Limited** and **Extended**. The default option is **Extended**.

BIOS-compatibility mapping—Extended. An option of BIOS compatibility mapping. When the BIOS compatibility mapping is set to **Extended**, the ServeRAID BIOS is aware that the operating system supports 8 GB or smaller physical drives.

BIOS-compatibility mapping—Limited. An option of BIOS compatibility mapping. When the BIOS compatibility mapping is set to **Limited**, the ServeRAID BIOS is aware that the operating system supports 2 GB or smaller physical drives. This enables the user to migrate data from older PCI or Micro Channel[®] adapters.

block. A data unit created when data is striped across physical drives.

blocked. A logical-drive state in which the data in a RAID level-0 logical drive might be damaged and will need to be restored. After an array fails and a rebuild operation is initiated, the ServeRAID controller sets RAID level-0 logical drives to the blocked state.

C

cluster. In ServeRAID technology, two independent computer systems organized into a network for the purpose of sharing resources and communicating with each other. A cluster provides fault-tolerance at the server level.

compression. The process by which a RAID level-5E logical drive utilizes the distributed spare drive in the

event of a physical drive failure. After the data is reconstructed, the original array undergoes compression and the distributed spare drive becomes part of the new array.

controller. A device that coordinates and controls the operation of one or more input/output devices, such as workstations, and synchronizes the operation of such devices with the operation of the system as a whole.

controller names. In a cluster or failover pair, the unique names that identify the members of the pair to one another.

critical. The state of a RAID level-1, level-1E, level-5, level-5E, level-10, level-1E0, or level-50 logical drive that contains a defunct drive.

D

data mirroring. A technique that creates a single logical drive from two physical drives. All data written to the logical drive is written to both physical drives, creating a pair of physical drives containing exactly the same data.

data scrubbing. A feature that provides automatic, continuous synchronization during system use. This feature works in the background, and ensures that the redundant data and/or parity is correct.

data striping. A technique that divides a logical drive into data blocks, called stripes, which are then distributed over the physical drives. The layout is such that a sequential read of data on the logical drive results in parallel reads to each of the physical drives, resulting in improved performance.

decompression. The process by which a compressed array returns to its original striping scheme, after a failed drive is replaced in a RAID level-5E logical drive. Contrast with compression.

defunct. A physical-drive state in which the ServeRAID controller cannot communicate properly with the drive.

distributed spare drive. In RAID level-5E, the logical drive designated as a spare drive. Because this spare drive is spread over several physical drives, it is described as distributed.

E

enclosure. A storage expansion unit, such as the Netfinity[®] EXP300, that contains SCSI disk drives.

F

fault tolerance. The ability of a computer system to operate correctly even though one or more of its component parts are malfunctioning.

firmware. Proprietary code that is usually delivered as microcode as part of an operating system. Firmware is more efficient than software loaded from an alterable medium and more adaptable to change than pure hardware circuitry. An example of firmware is the Basic Input/Output System (BIOS) in read-only memory (ROM) on a PC motherboard.

H

hot add. To add and configure a new ServeRAID controller while the server is operational.

hot-spare drive. A physical drive that is defined for automatic use when a similar drive fails.

hot-pluggable. Pertaining to a system in which components can be added while the system is running.

hot-swappable. Pertaining to a component that can be removed or replaced while the system is running.

hot-swap rebuild. An operation that is started by the ServeRAID controller when it detects that a physical drive that is part of an array and in the defunct state has been removed and replaced on a SCSI cable or backplane.

I

integrated RAID controller. An integrated SCSI controller with RAID capabilities, such as the LSI 1020 and LSI 1030. These integrated RAID controllers are standard features on some IBM xSeries servers; they can be used to create a RAID level-1 logical drive from two physical drives. A third physical drive can be used as a hot-spare drive.

initialize logical drive. In the ServeRAID utilities, to erase the first 1024 sectors on a drive, preventing access to any data previously stored on the drive.

initiator identifiers. The SCSI initiator IDs assigned to a cluster or failover pair.

IPSEND command-line program. An advanced command-line program that can be used to manage your ServeRAID controllers. It can be used to configure your controller, isolate and debug problems, recover from errors, and to copy controller configurations from one server to another.

L

logical drive. A grouping of physical drives that the operating system recognizes as a single drive.

logical-drive migration. To add or remove physical drives from an existing array, to change RAID levels, change logical-drive size, or effect an increase in free space.

M

merge-group number. In a clustering configuration, the numbers that identify each logical drive. Non-shared logical drives are assigned merge-group numbers of either 206 or 207; shared logical drives need unique merge-group numbers, so that they can be identified even if they move to the other server.

merge-group state. In a clustering environment, whether or not a logical drive is shared.

migrating. The state of a logical drive undergoing a logical-drive migration.

mirror role. The role assigned to the two physical drives that an integrated RAID controller uses to create a RAID level-1 logical drive. When the logical drive is created, data is copied from the primary physical drive to the secondary physical drive. Any data on the secondary drive is destroyed.

N

Notification Manager. A tool used to notify remote systems of events, problems, and configuration changes occurring on a local system.

O

offline. A logical-drive state in which the logical drive is inaccessible.

okay. A logical-drive state in which the logical drive is functional.

online. A physical-drive state in which the physical drive is functioning properly and is part of an array.

P

partner name. In a cluster or failover pair, one of the two controller names entered during configuration.

parity. The data stored on a RAID level-5, level-5E, or level-50 logical drive that can be used, in conjunction with the data on the remaining drives, to recreate a failed physical drive's data.

parity block. In a RAID level-5, level-5E, or level-50 logical drive, a data unit that contains a representation of the data from other blocks in the same stripe.

physical drive. A hard disk drive.

POST. Power-on self-test. During POST, the ServeRAID controller compares the stored configuration information to the configuration that is actually present. If a discrepancy exists, one or more status messages appear after the POST completes but before the operating system loads.

Q

quorum drive. In the Microsoft Clustering Solution, a logical drive that stores the quorum resource information.

R

rack enclosure. See enclosure.

RAID. A technology of grouping several physical drives in a computer into an array that you can define as one or more logical drives. Each logical drive appears to the operating system as a single drive. This grouping technique greatly enhances logical-drive capacity and performance beyond the physical limitations of a single physical drive.

RAID level-0. A RAID level that uses data striping to distribute data evenly across physical drives. While it enables full utilization of physical drive capacity and performance acceleration, RAID level-0 provides neither fault tolerance nor redundancy.

RAID level-1. A RAID level that uses data mirroring to distribute data across two physical drives. It provides data redundancy and performance acceleration, although the usable physical drive space is reduced by 50 percent.

RAID level-1E. A RAID level that uses both data striping and data mirroring to distribute data across three or more physical drives. Data is striped across each disk in the array; the first set of stripes are the data stripes, and the second sets of stripes are mirror copies of the first stripe, shifted one drive. It provides data redundancy and performance acceleration, although the usable physical drive space is reduced by 50 percent.

RAID level-5. A RAID level that uses data striping and block interweaving to distribute data across three or more physical drives. It provides full data protection and performance acceleration, although only 67-94% of physical drive storage capacity can be used.

RAID level-5E. A RAID level that uses data striping and block interweaving to distribute data across four or

more physical drives; it uses some space on each physical drive as a distributed hot-spare. It provides full data protection and performance acceleration, although only 50-88% of physical drive storage capacity can be used.

RAID level-x0. Refers to RAID level-00, level-10, level-1E0, and level-50. These RAID levels use spanned arrays (arrays of arrays) to enable the use of up to 60 physical drives. RAID level-00 provides no data redundancy, but provides performance acceleration and allows 100% of the physical drive storage capacity to be used. RAID levels -10, -1E, and -50 provide full data protection, performance acceleration, and greater reliability, although only 67-94% of physical drive storage capacity can be used.

read-ahead cache mode. A ServeRAID controller setting that determines whether the ServeRAID controller transfers data from disk to its local cache in increments equal to the stripe-unit size or the system I/O requests. The options are **enabled**, **disabled**, and **adaptive**; the default option is adaptive.

read-ahead cache mode—Adaptive. The default-value of the read-ahead cache mode. When the read-ahead cache mode is set to adaptive, the ServeRAID controller continually reevaluates whether to set the read-ahead cache mode to **enabled** or **disabled**.

read-ahead cache mode—Disabled. An option of the read-ahead cache mode. When the read-ahead cache mode is disabled, the ServeRAID controller transfers data from the logical drive to its local cache in increments equal to the system I/O request size. This optimizes performance when the workload is random or the system I/O requests are smaller than the stripe-unit size.

read-ahead cache mode—Enabled. An option of the read-ahead cache mode. When the read-ahead cache mode is enabled, the ServeRAID controller transfers data from the logical drive to its local cache in increments equal to the stripe-unit size. This optimizes performance when workloads are steady and sequential.

ready. A physical-drive state in which the drive is available for definition.

rebuild. An operation to reconstruct data after the problem that caused a physical drive to become defunct has been resolved.

rebuilding. The state of a physical drive undergoing a rebuild operation.

rebuild rate. The speed (high, medium, or low) at which a rebuild operation will occur.

redundant array of independent disks (RAID). See RAID.

restore to factory-default settings. An action that restores all parameters in the controller to the factory-default settings. If logical drives are defined, the data stored on them will be lost.

S

SCSI. See small computer system interface.

SCSI ID. A unique ID assigned to each SCSI device connected to a SCSI controller. This ID enables the controller to identify the device and ensure that different devices on the same SCSI channel do not transfer data simultaneously.

SCSI initiator ID. In a failover or clustering environment, the ID assigned to a SCSI controller. Each ServeRAID controller and its partner must have different SCSI initiator IDs; one must be 6 and the other 7.

SCSI transfer speed. The speed at which data can be transferred between a physical drive and the ServeRAID controller.

ServeRAID Manager. A program used to configure ServeRAID controllers, view the ServeRAID configuration, create arrays and logical drives, delete arrays, dynamically increase the logical-drive size, change RAID levels, and more.

ServeRAID Mini-Configuration program. A program that allows the user to display the ServeRAID controller settings, and to perform a limited set of configuration functions without using the *IBM ServeRAID Support CD*.

ServeRAID ROM Update Wizard. A program that updates the BIOS and firmware codes on ServeRAID controllers.

shared drives. The physical drives controlled by a cluster or failover pair.

small computer system interface. A standard hardware interface that enables a variety of peripheral devices to communicate with one another.

spanned array. An array of arrays. Used in RAID level-00, level-10, level-1E0, and level-50 to permit the use of larger numbers of physical drives. The spanned array contains arrays, each of which contains a sub-logical drive, which can be RAID level-0, level-1, level-1E, or level-5. The RAID-level for the logical drive contained within the spanned array is 0.

standby hot spare. A hot-spare physical drive that the ServeRAID controller has spun down. If an online drive becomes defunct and no suitable hot-spare drive is available, a standby drive of the appropriate size automatically spins up and enters the rebuild state.

stripe-unit size. The granularity at which data is stored on one drive of the array before subsequent data is stored on the next drive of the array. The

performance of a ServeRAID controller is maximized if the stripe-unit size is close to the size of the system input/output requests.

stripes. The collection of stripe units, from the first to last drive of the array.

sub-logical drive. In a RAID level-x0 configuration, a logical drive contained within each array of the spanned array. A sub-logical drive can be RAID level-0, level-1, level-1E, or level-5.

synchronization. The process of recalculating and rewriting either redundant data (RAID level-1, level-1E, level-10, and level-1E0 logical drives) or parity (RAID level-5, level-5E, and level-50 logical drives).

T

throughput. The speed at which data can be moved from one place to another, usually expressed in MB per second.

U

unattended mode. A ServeRAID controller setting that determines how the BIOS handles failures during system startup. The options are **enabled** and **disabled**; the default value is **disabled**.

unattended mode—Disabled. An option of the unattended mode. When the unattended mode is disabled and the BIOS detects a failure, the system stops at the recovery option screen and waits for the user to respond.

unattended mode—Enabled. An option of the unattended mode. When the unattended mode is enabled and the BIOS detects a failure, the system waits for 30 seconds for the user to respond to the recovery option screen. Then, the BIOS automatically selects an appropriate option and continues the system startup process. Unattended mode must be enabled in a clustering environment.

W

write-cache mode. A ServeRAID controller setting that determines whether the controller writes data to the physical drive before or after sending a confirmation to the operating system. The settings are **write back** and **write through**.

write-cache mode—write back. A setting of the write-cache mode. When the write-cache mode is set to write back and the operating system sends data to the controller, the controller sends a confirmation back to the operating system before actually writing the data to a storage device. This increases performance, but, if a battery-backup cache is not used, increases the risk of data loss in the event of a power failure.

write-cache mode—write through. A setting of the write-cache mode. When the write-cache mode is set to write through and the operating system sends data to the controller, the controller writes the data to a storage device before sending a confirmation to the operating system. This mode decreases performance, but does not risk data loss.

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