IBM Shared Disk Clustering

Hardware Reference

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> **Note**
>
> Before using this information and the product it supports, be sure to read the general information under "Notices" on page 81.

Contents

About This Book

This reference is intended for anyone who wants to configure a shared-disk cluster using IBM Netfinity and PC Server products. It contains illustrations, descriptions, and parts listings for various shared-disk cluster examples. These low-cost, high-availability cluster examples all use IBM ServeRAID II Ultra SCSI Adapters, IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapters, or IBM Netfinity Fibre Channel RAID Controllers to manage the shared-disk resources.

This reference does not provide installation instructions or specific instructions for performing procedures. That information is provided in the documentation that comes with the IBM Netfinity or PC Server product.

How This Book Is Organized

"Introduction to Shared Disk Clustering," provides basic information to help you understand the purpose and physical structure of shared-disk clusters. This information will help you design a cost-effective, shared-disk cluster that meets your needs today, while providing flexible expansion capabilities for the future.

"Shared-Disk Hardware Examples," contains illustrations, descriptions, and parts listings for several high-availability, shared-disk cluster examples. These cost-effective clusters consist exclusively of IBM Netfinity and PC Server products.

"Selecting Servers and Enclosures," provides general information about the IBM servers, storage enclosures, and optional devices used to create the high-availability, shared-disk cluster examples that appear in Chapter 2 of this reference.

"Notices," contains special notices, such as the trademarks used in this book.

Related Information

The *IBM Server Paper Configurator Guide* provides detailed configuration information and part numbers for currently marketed IBM Netfinity and PC Server products. You can download an up-to-date copy of this document from the following World Wide Web page:

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http://www.pc.ibm.com/us/products/server/download.html
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Additional web sites that contain shared-disk clustering information include the following:

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http://www.pc.ibm.com
http://www.pc.ibm.com/support
http://www.pc.ibm.com/us/options/
http://www.pc.ibm.com/us/netfinity/
http://www.pc.ibm.com/us/netfinity/clustering.html
```

You can select a country-specific Web site from these pages.

Introduction to Shared Disk Clustering

Your productivity and satisfaction, as well as the productivity and satisfaction of everyone on your network, depends not only on the performance, but also on the availability of your servers. Many factors can influence the availability of your servers, including your hardware configuration.

IBM® recently announced the availability of several clustering software packages specifically designed for use with IBM Netfinity® and PC Server hardware. Using these software packages, you can cost-effectively configure high-availability, shared-disk clusters using Netfinity and PC Server products.

Overview of a Shared Disk Cluster

In a traditional environment, specific servers control specific drive resources. Thus, when a specific server goes offline due to a subsystem failure or for scheduled maintenance, the drive resources controlled by that server also go offline and are no longer available. This is a very common situation; but clearly, it is not a desirable one. You can avoid this situation and keep the drive resources of a specific server available, even if subsystems within that server fail, by implementing a high-availability, shared-disk cluster.

Figure 1 on page 2 shows a very simple view of a shared-disk cluster. In a dual-node, shared-disk cluster environment, two identical (or very similar) servers share the same drive resources. The shared-drive resources reside in a separate storage expansion enclosure, and cabling between each server (sometimes called a *node*) and the expansion enclosure provides both servers equal access to the shared drives.

When both servers are online in this "active/active" clustered environment, the servers share the workload because each server can control and manage specific shared-disk resources. In the event that one server fails or goes offline for scheduled maintenance, the remaining active server automatically assumes control of all shared-disk resources and keeps them available.

Notes:

 1. The cluster software packages were designed and tested for use with the high-availability functions provided by the IBM ServeRAID II Ultra SCSI Adapter, the IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter, or the IBM Netfinity Fibre Channel RAID Controller.

 2. To support clustered configurations, the ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

 3. All dual-node, shared-disk cluster examples that appear in this reference use IBM ServeRAID II Ultra SCSI Adapters, IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapters, or IBM Netfinity Fibre Channel RAID Controllers to manage the shared-disk resources.

Both servers continuously monitor each other's functional status through a network-crossover cable. This network-crossover cable, sometimes referred to as the cluster's *heartbeat*, connects two IBM PCI EtherJet™ Adapters (one in each server) and provides the dedicated, point-to-point communication link between the servers.

Note: You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.
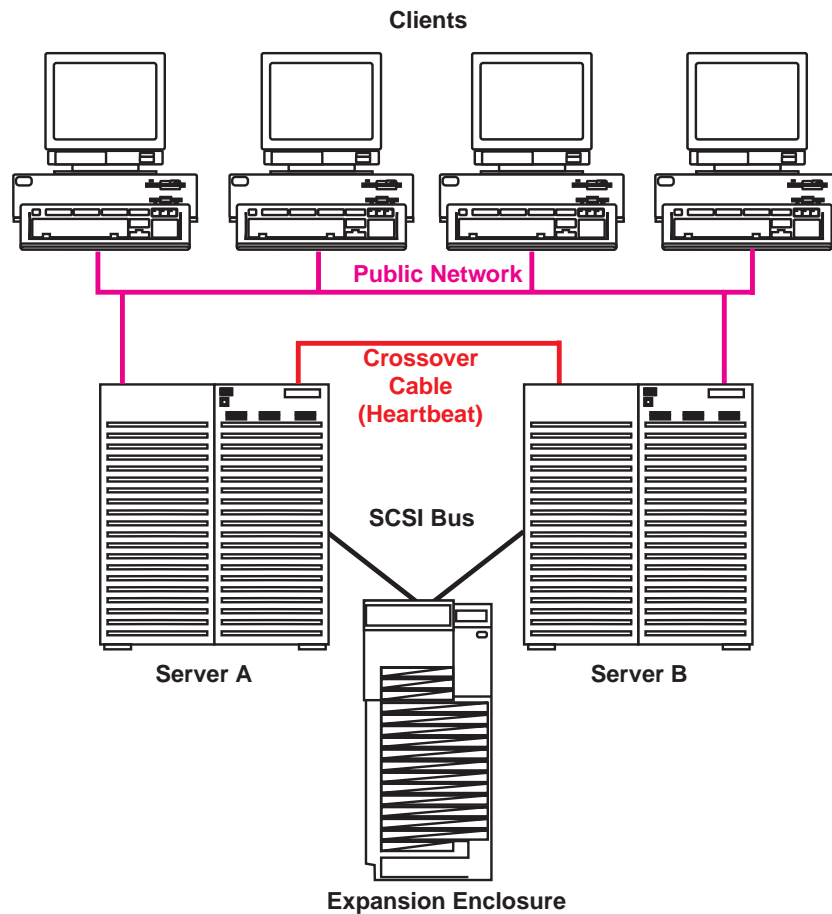
Figure 1. Simple Shared-Disk Cluster

Planning for a Shared Disk Cluster

One of the most important elements in configuring a shared-disk cluster is thorough, up-front planning. This section provides some basic considerations, ideas, and information that you might find useful when designing a shared-disk cluster.

To help you determine the appropriate hardware for your shared-disk cluster, consider the following:

- **What are the objectives and functional requirements for the cluster?**

  Know what problems are to be resolved and what expectations have been identified as reasons for implementing the cluster.

- **What are the long-term requirements for the cluster?**

  Planning for future growth will help you select servers and expansion enclosures that you can expand easily as the needs of your business increase.

- **What type of application software will reside on the servers and what type of data will reside on the shared disks?**

  Evaluating the type of data and software applications will help you determine if additional memory or microprocessors might be required. For example, if the data requires extensive computation, you might need to install additional microprocessors in the servers to maintain adequate performance for your environment.

- **What are the disk-storage requirements for the cluster?**

  Understanding the disk-storage requirements will help you select storage enclosures and hard disk drives that meet your needs today and provide expansion capabilities for the future.

- **In addition to the shared disks, are there any other mission-critical functions that the clustered servers will need to provide?**

  Considering all requirements will help you determine if each server might require additional memory, microprocessors, I/O slots, or drive bays. Keep in mind that the shared-disk cluster will use two or three PCI expansion slots and two or more drive bays in each server.

Other considerations might include such things as your budget and security needs. An important point to remember is that a decision to use a specific configuration does not limit future expansion. Many of the IBM Netfinity and PC Server hardware elements used to create the shared-disk clusters are very flexible and can be customized and expanded as your needs increase.

"Shared-Disk Hardware Examples" contains illustrations, descriptions, and parts listings for several dual-node, shared-disk cluster examples.

For detailed information about the IBM servers, storage enclosures, and optional devices that you can use to configure a shared-disk cluster, see "Selecting Servers and Enclosures."

Shared-Disk Hardware Examples

This section contains descriptions, illustrations, and parts lists for nine example shared-disk cluster configurations. These nine cluster examples will help you understand the flexibility and basic structure of high-availability, shared-disk clusters. Depending on the objectives for your shared-disk cluster, some hardware configurations might be more suitable than others.

Software Considerations

The shared-disk cluster examples that appear in this reference are designed for use with the high-availability features of the IBM ServeRAID II Ultra SCSI Adapter, the IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter, or the IBM Netfinity Fibre Channel RAID Controller using the clustering programs provided in the Netfinity Cluster Pack by Vinca, IBM Part Number 01K8018.

This section also provides the instructions needed to modify the cluster examples for use with Microsoft Cluster Server. The Microsoft Cluster Server software requires the use of a *quorum* drive, which is a shared logical drive that both servers can use to store and retrieve data.

Important Quorum Information

- The servers must share the quorum logical drive. Therefore, the physical drives used when defining the quorum logical drive must reside in one of the storage expansion enclosures with the other shared drives.

- The cluster software stores several MB[1] of data on the quorum drive. You can use the remaining space in the quorum logical drive to store other application programs and data.

- The quorum drive presents a single point of failure. If this logical drive becomes defunct, the failover and failback functions will not occur. To help maintain high availability, define a RAID level-1 logical drive for use as the quorum drive.

- When using the Microsoft Cluster Server program with the IBM ServeRAID II or ServeRAID-3H adapters, you also must connect Channel 3 of a ServeRAID adapter in Server A to Channel 3 of a ServeRAID adapter in Server B; then, define the quorum drive as a RAID level-1 logical drive on Channel 1 or Channel 2 of the same pair of ServeRAID adapters. When one server fails, this dedicated *quorum-arbitration link* is used to locate and then transfer control of the shared disks to the nonfailing server.

  Note: You must use Channel 3 of the ServeRAID adapters that connect to the quorum logical drive as a dedicated quorum-arbitration link. Do not connect any other devices to this channel.

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[1] MB equals approximately 1 000 000 bytes.

PC Server 325 Tower Cluster Example

Figure 2 shows a low-cost, high-availability, shared-disk cluster consisting of two tower models of the PC Server 325 and one PC Server 3518 Enterprise Expansion Enclosure. In addition to its standard features, each PC Server 325 contains one IBM ServeRAID II Ultra SCSI Adapter, one IBM 100/10 PCI EtherJet Adapter, and one additional 4.51 GB[2] hard disk drive. (See "Parts List for the PC Server 325 Tower Cluster Example" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.
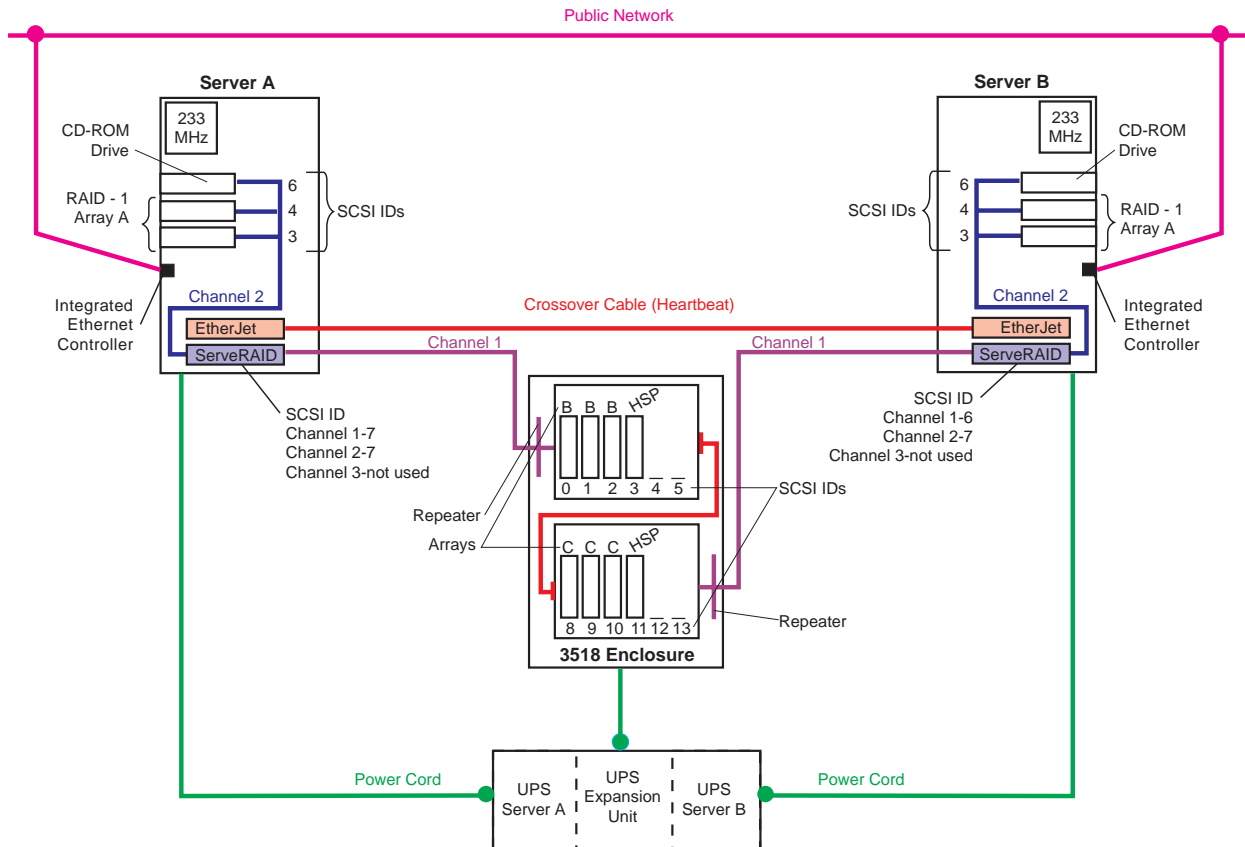
Figure 2. PC Server 325 Tower Cluster Example

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects the IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. The servers connect to the public network using the Ethernet controllers on the system boards. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

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[2] When referring to hard-disk-drive capacity, GB means 1 000 000 000 bytes; total user-accessible capacity may vary depending on operating environment.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

To maintain high availability, the two hard disk drives in each server are defined as RAID level-1 logical drives (Array A) using Channel 2 of the ServeRAID adapters. Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program.

The internal SCSI cables remain attached to the CD-ROM drives, but the end connectors that were attached to the SCSI controllers on the system boards are now attached to the Channel 2 connectors on the ServeRAID adapters. The hard disk drive attached to the end connector on the internal SCSI cable in each server has its termination set to Enabled. The other hard disk drive in each server has its termination set to Disabled.

Note: The termination for the CD-ROM drive is permanently set to Disabled. You can not Enable termination on the CD-ROM drive.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1 and 2 of the ServeRAID adapter in Server A are set to SCSI ID 7. Channel 1 of the ServeRAID adapter in Server B is set to SCSI ID 6, because it shares the same SCSI bus as Channel 1 of the ServeRAID adapter in Server A. Channel 2 of the ServeRAID adapter in Server B connects to the nonshared drives and is set to SCSI ID 7 to avoid a conflict with the CD-ROM drive, which is set to SCSI ID 6. On both ServeRAID adapters, Channel 3 is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

In addition to the standard features of the PC Server 3518, the expansion enclosure contains a power-supply upgrade option, an additional backplane, two enhanced SCSI repeaters, and cables. The maximum achievable hot-swap storage capacity[3] for this enclosure is 163.8 GB using eighteen 9.1 GB drives. However, this example shows only eight drives, which leaves space for future expansion.

To help maintain high availability, the eight hard disk drives are defined as two RAID level-5 logical drives (arrays B and C). To further increase the availability of these shared drives, each ServeRAID adapter has its own hot-spare (HSP) drive. A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

The jumpers on the backplane in Bank D are set for Bank D and for high addressing (SCSI IDs 8, 9, 10, 11, 12, and 13). A cable connects the Bank C and Bank D backplanes, creating one continuous SCSI bus.

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[3] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

Channel 1 of the ServeRAID adapter in Server A connects to the enhanced SCSI repeater that connects to Bank C, and Channel 1 of the ServeRAID adapter in Server B connects to the enhanced SCSI repeater that connects to Bank D. The enhanced SCSI repeaters contain circuits that can automatically sense the functional status of the server. When the SCSI repeater circuitry detects that the server attached to it is failing or offline, the SCSI repeater automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the PC Server 325 Tower Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. In Server B, use the ServeRAID utility program to change the ServeRAID adapter Channel 3 SCSI ID from 7 to 6.

2. Install a Third Channel Cable Option on the ServeRAID adapters in both servers.

   Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

3. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to the external Channel 3 connector on one of the ServeRAID adapters.

4. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of the ServeRAID adapter in Server A to Channel 3 of the ServeRAID adapter in Server B.

5. Install two additional hard disk drives in Banks C or D.

6. Define the two drives as one RAID level-1 logical drive; then, use that logical drive as your quorum drive.

Parts List for the PC Server 325 Tower Cluster Example

Quantity	Part Number	Description
2	8639-PTW	PC Server 325 (this model comes with one 4.51 GB hard disk drive)
2	76H3584[4]	IBM ServeRAID II Ultra SCSI Adapter (one for each server)
2	Varies[5]	Ethernet cables (to connect the servers to the public network)
1	3518001	PC Server 3518 Enterprise Storage Expansion Enclosure
8	02K0477	9.1 GB Wide Ultra SCSI Hot-Swap Hard Disk Drive (slim line)
2	76H2687	Ultrastar™ 4.51 GB Wide Ultra SCSI (one additional for each server)
1[6]	94G7584	Shared Disk Convenience Kit This kit contains the following: • 1 76H2670 Hot-Swap Backplane III • 2 94G7585[7] SCSI-2 Fast/Wide Enhanced Repeaters • 1 94G7593 Power Supply Upgrade II option • 2 86H2432 IBM 100/10 PCI EtherJet Adapters • 2 94G4070 Backplane-to-Backplane cable • 1 70G9876 Expansion Enclosure Backplane Cable • 1 76H0551[8] Ethernet Crossover cable • 2 01K8029 4.3 Meter External 68-pin SCSI Cable
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
1	01K8029	4.3 Meter External 68-pin SCSI Cable (required, in addition to the two provided in the convenience kit, for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[9]	Uninterruptible Power Supplies

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[4] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[5] Must be purchased separately. Part numbers vary.

[6] If you want to increase the high-availability features of the 3518 expansion enclosure by using the 780 Watt Redundant Power Supply, do not purchase the convenience kit. Instead, purchase the individual components provided in the convenience kit, but replace the Power Supply Upgrade II option with the 780 Watt Redundant Power Supply option, Part Number 94G4701.

[7] The SCSI-2 Enhanced Repeater, Part Number 94G5565, is not supported in cluster configurations.

[8] This cable is not available for separate purchase. This Category 5 cable is designed for point-to-point connections and has RJ-45 connectors on each end.

[9] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

PC Server 325 Rack Cluster Example 1

Figure 3 shows a low-cost, high-availability, shared-disk cluster consisting of two rack models of the PC Server 325 and one Netfinity EXP10 enclosure. In addition to its standard features, each PC Server 325 contains one IBM ServeRAID II Ultra SCSI Adapter, one IBM 100/10 PCI EtherJet Adapter, and two 4.51 GB hard disk drives. (See "Parts List for the PC Server 325 Rack Cluster Example 1" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.
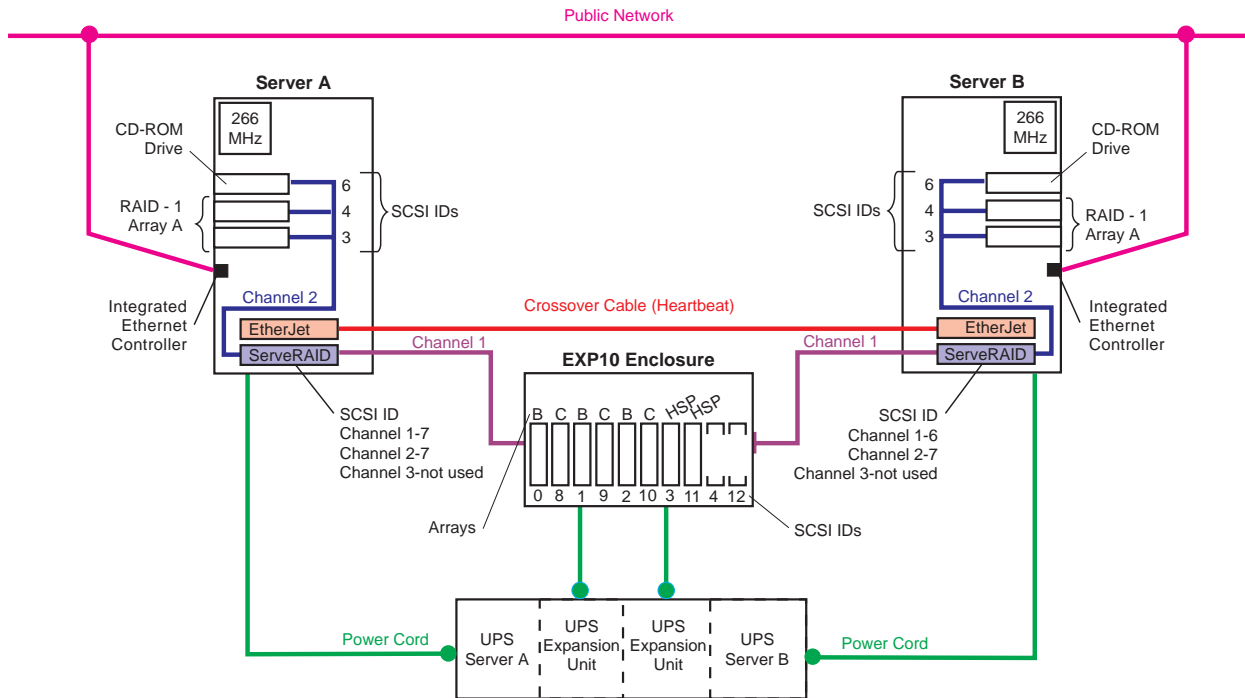
Figure 3. PC Server 325 Rack Cluster Example 1

The capacity of the Netfinity Rack is 42U. Each server occupies 5U and the EXP10 enclosure occupies 3U. You can house this 13U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in one IBM Netfinity Rack or in an industry-standard, 19-inch rack that meets EIA-310-D standards and has a minimum depth of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

In this example, the server hardware is configured the same as in the Entry Tower Cluster example, which appears in Figure 2. However, by using the rack-model server and the Netfinity EXP10 storage enclosure, the amount of physical space needed to store the cluster decreases significantly and the overall storage capacity increases by 18.2 GB[10]. (Each 3518 enclosure can support eighteen 9.10 GB hot-swap drives, and each Netfinity EXP10 enclosure can support ten 18.2 GB hot-swap drives.)

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects the IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional

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[10] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

status. The servers connect to the public network using the Ethernet controllers on the system boards. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

To maintain high availability, the two hard disk drives in each server are defined as RAID level-1 logical drives (Array A) using Channel 2 of the ServeRAID adapters. Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program.

The internal SCSI cables remain attached to the CD-ROM drives, but the end connectors that were attached to the SCSI controllers on the system boards are now attached to the Channel 2 connectors on the ServeRAID adapters. The hard disk drive attached to the end connector on the internal SCSI cable in each server has its termination set to Enabled. The other hard disk drive in each server has its termination set to Disabled.

Note: The termination for the CD-ROM drive is permanently set to Disabled. You can not Enable termination on the CD-ROM drive.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1 and 2 of the ServeRAID adapter in Server A are set to SCSI ID 7. Channel 1 of the ServeRAID adapter in Server B is set to SCSI ID 6, because it shares the same SCSI bus as Channel 1 of the ServeRAID adapter in Server A. Channel 2 of the ServeRAID adapter in Server B connects to the nonshared drives and is set to SCSI ID 7 to avoid a conflict with the CD-ROM drive, which is set to SCSI ID 6. On both ServeRAID adapters, Channel 3 is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

The maximum storage capacity[11] for a Netfinity EXP10 is 182 GB, using ten 18.2 GB hot-swap drives. However, this example shows eight 9.1 GB hot-swap hard disk drives, which provides space for future expansion. To help maintain high availability, the drives are grouped into two RAID level-5 logical drives (arrays B and C). To further increase the availability of the shared drives, each ServeRAID adapter has its own hot-spare (HSP) drive. A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

A SCSI cable (provided with the expansion enclosure) connects the SCSI Bus 1 OUT and SCSI Bus 2 IN connectors on the rear of the enclosure, forming one continuous SCSI bus.

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[11] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

Using auto-sensing cables, Channel 1 of the ServeRAID adapter in Server A is connected to the SCSI Bus 1 IN connector, and Channel 1 of the ServeRAID adapter in Server B is connected to the SCSI Bus 2 OUT connector.

Note: To help increase the availability of the shared disks and enable the serviceability of a failing or offline server, you must use Netfinity EXP10 Auto-Sensing Cables, IBM Part Number 03K9352, to connect clustered servers to Netfinity EXP10 enclosures.

The EXP10 auto-sensing cables contain circuits that can automatically sense the functional status of the server. When the circuitry in an auto-sensing cable detects that the server attached to it is failing or offline, the cable circuitry automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server.

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP10 enclosure. The IDs alternate between low and high addresses, and might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments from left (bay 1) to right (bay 10) are: 0 8 1 9 2 10 3 11 4 12.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the PC Server 325 Rack Cluster Example 1

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. Install two additional drives in the enclosure.

2. Define the two drives as one RAID level-1 logical drive; then, use that logical drive as your quorum drive.

3. In Server B, use the ServeRAID utility program to change the ServeRAID adapter Channel 3 SCSI ID from 7 to 6.

4. Install a Third Channel Cable Option on the ServeRAID adapters in both servers.

   Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

5. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to the external Channel 3 connector on one of the ServeRAID adapters.

6. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of the ServeRAID adapter in Server A to Channel 3 of the ServeRAID adapter in Server B.

Parts List for the PC Server 325 Rack Cluster Example 1

Quantity	Part Number	Description
2	8639-RB0	Rack-ready model of the PC Server 325
1	35201RU	Netfinity EXP10 enclosure
2	76H3584[12]	IBM ServeRAID II Ultra SCSI Adapter (one for each server)
2	03K9352	Netfinity EXP10 3.0 Meter External Auto-Sensing Cable
2	86H2432	IBM 100/10 PCI EtherJet Adapter (one for each server)
2	Varies[13]	Ethernet cables (to connect the servers to the public network)
1	None[14]	Ethernet Crossover Cable
8	01K7959	9.10 GB Wide Ultra SCSI SCA-2
4	76H2687	Ultrastar 4.51 GB Wide Ultra SCSI (two for each server)
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
1	01K8029	4.3 Meter External 68-pin SCSI Cable (required for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[15]	Uninterruptible Power Supplies

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[12] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[13] Must be purchased separately. Part numbers vary.

[14] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[15] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

PC Server 330 Tower Cluster Example

Figure 4 shows a low-cost, high-availability, shared-disk cluster consisting of two PC Server 330 systems and two PC Server 3518 Enterprise Expansion Enclosures. In addition to its standard features, each PC Server 330 contains two 266 MHz Intel® Pentium® II microprocessors with 512 KB[16] of level-2 cache (one microprocessor standard), 128 MB[17] of ECC system memory (64 MB standard), two 4.51 GB hot-swap hard disk drives, one IBM 100/10 PCI EtherJet Adapter, and one IBM ServeRAID II Ultra SCSI Adapter. (See "Parts List for the PC Server 330 Tower Cluster Example" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.
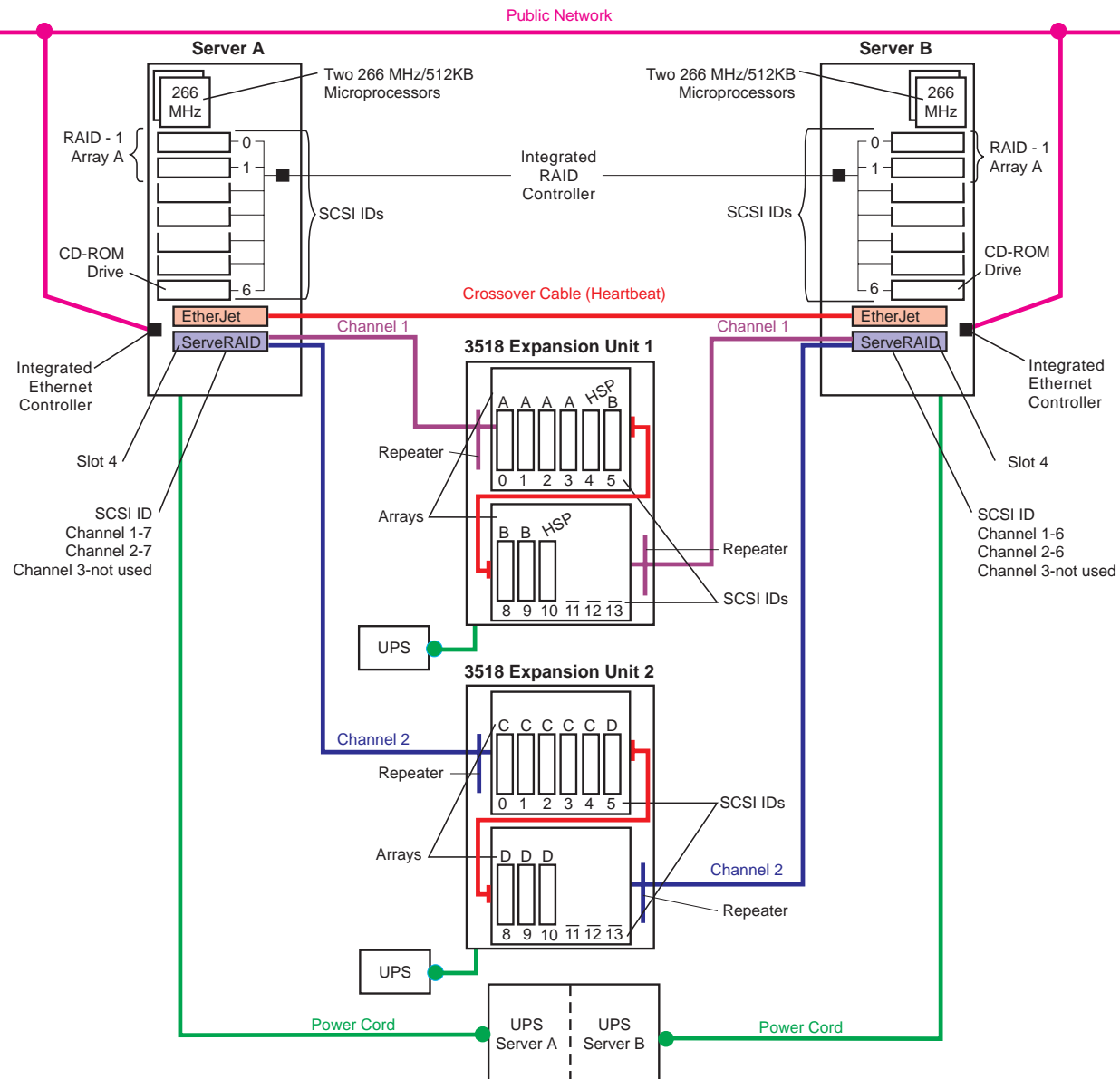
Figure 4. PC Server 330 Tower Cluster Example

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[16] KB equals approximately 1 000 bytes.

[17] MB equals approximately 1 000 000 bytes.

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects the IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. The servers connect to the public network using the Ethernet controllers on the system boards. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

 1. You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

 2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

 3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

To maintain high availability, the two hard disk drives in each server are defined as RAID level-1 logical drives (Array A) using the single-channel ServeRAID controller on the system board. Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program. Notice that the ServeRAID adapters are installed in PCI slot 4. When you use the integrated RAID controller to manage the startup (boot) drives, you must install the ServeRAID adapters that will manage the shared drives in PCI slot 4, 5, or 6 (respectively) to avoid a PCI bus conflict during startup.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1 and 2 of the ServeRAID adapter in Server A are set to SCSI ID 7, and Channels 1 and 2 of the ServeRAID adapter in Server B are set to SCSI ID 6. On both ServeRAID adapters, Channel 3 is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

In this example, the 3518 expansion enclosures have identical hardware configurations. In addition to the standard features of the 3518, the enclosures each contain a power-supply upgrade option, an additional backplane, and two enhanced SCSI repeaters. The maximum achievable hot-swap storage capacity for each enclosure is 163.8 GB using eighteen 9.1 GB drives. However, this example shows only nine 9.1 GB drives in each enclosure, and provides space for future expansion. To help maintain high availability, the 18 hard disk drives are defined as four RAID level-5 logical drives (arrays A, B, C, and D). To further increase the availability of these shared drives, each ServeRAID adapter has its own hot-spare (HSP) drive. A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

In both enclosures, the jumpers on the backplanes in Bank D are set for Bank D and for high addressing (SCSI IDs 8, 9, 10, 11, 12, and 13). A cable connects the Bank C and Bank D backplanes, creating one continuous SCSI bus in each enclosure.

Channel 1 of the ServeRAID adapter in Server A connects to the enhanced SCSI repeater that connects to Bank C of expansion unit 1, and Channel 1 of the ServeRAID adapter in Server B connects to the enhanced SCSI repeater that connects to Bank D of expansion unit 1. Channel 2 of the ServeRAID adapter in Server A connects to the enhanced SCSI repeater that connects to Bank C of expansion unit 2, and Channel 2 of the ServeRAID adapter in Server B connects to the enhanced SCSI repeater that

connects to Bank D of expansion unit 2. The enhanced SCSI repeaters contain circuits that can automatically sense the functional status of the server. When the SCSI repeater circuitry detects that the server attached to it is failing or offline, the SCSI repeater automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the PC Server 330 Tower Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. Install two additional drives in Bank D of either expansion unit.

2. In Server B, use the ServeRAID utility program to change the ServeRAID adapter Channel 3 SCSI ID from 7 to 6.

3. Define the two drives as one RAID level-1 logical drive; then, use that logical drive as your quorum drive.

4. Install a Third Channel Cable Option on the ServeRAID adapters in both servers.

   Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

5. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to the external Channel 3 connector on one of the ServeRAID adapters.

6. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of the ServeRAID adapter in Server A to Channel 3 of the ServeRAID adapter in Server B.

   Note: The ServeRAID adapter must be installed in PCI slot 4, 5, or 6 when using the on-board RAID controller to manage the startup (boot) drives.

Parts List for the PC Server 330 Tower Cluster Example

Quantity	Part Number	Description
2	8640-PB0	PC Server 330
2	94G6474	64 MB, 60 ns, EDO ECC DIMM (one for each server)
2	01K6600	266 MHz Pentium II Microprocessor Upgrade with 512 KB of Level-2 Cache (one for each server)
2	76H3584[18]	IBM ServeRAID II Ultra SCSI Adapter (one for each server)
2	Varies[19]	Ethernet cables (to connect the servers to the public network)
2	3518001	PC Server 3518 Enterprise Storage Expansion Enclosure
4	94G7491	4.51 GB Wide Ultra SCSI Hot-Swap Hard Disk Drive
18	02K0477	9.1 GB Wide Ultra SCSI Hot-Swap Hard Disk Drive (slim line)
2[20]	94G7584	Shared Disk Convenience Kit Each kit contains the following: • 1 76H2670 Hot-Swap Backplane III • 2 94G7585[21] SCSI-2 Fast/Wide Enhanced Repeaters • 1 94G7593 Power Supply Upgrade II option • 2 86H2432 IBM 100/10 PCI EtherJet Adapters • 2 94G4070 Backplane-to-Backplane cable • 1 70G9876 Expansion Enclosure Backplane Cable • 1 76H0551[22] Ethernet Crossover cable • 2 01K8029 4.3 Meter External 68-pin SCSI Cable
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
1	01K8029	4.3 Meter External 68-pin SCSI Cable (required, in addition to the four provided in the convenience kits, for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[23]	Uninterruptible Power Supplies

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[18] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[19] Must be purchased separately. Part numbers vary.

[20] If you want to increase the high-availability features of the 3518 expansion enclosure by using the 780 Watt Redundant Power Supply, do not purchase the convenience kit. Instead, purchase the individual components provided in the convenience kit, but replace the Power Supply Upgrade II option with the 780 Watt Redundant Power Supply option, Part Number 94G4701.

[21] The SCSI-2 Enhanced Repeater, Part Number 94G5565, is not supported in cluster configurations.

[22] This cable is not available for separate purchase. This Category 5 cable is designed for point-to-point connections and has RJ-45 connectors on each end.

[23] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

PC Server 325 Rack Cluster Example 2

Figure 5 shows a low-cost, high-availability, shared-disk cluster consisting of two rack models of the PC Server 325 and two Netfinity EXP10 enclosures. In addition to its standard features, each PC Server 325 contains two 266 MHz Intel Pentium II microprocessors with 512 KB of level-2 cache (one microprocessor standard), 128 MB of ECC system memory (64 MB standard), two 4.51 GB hard disk drives, two IBM 100/10 PCI EtherJet Adapters, and one IBM ServeRAID II Ultra SCSI Adapter. (See "Parts List for the PC Server 325 Rack Cluster Example 2" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.
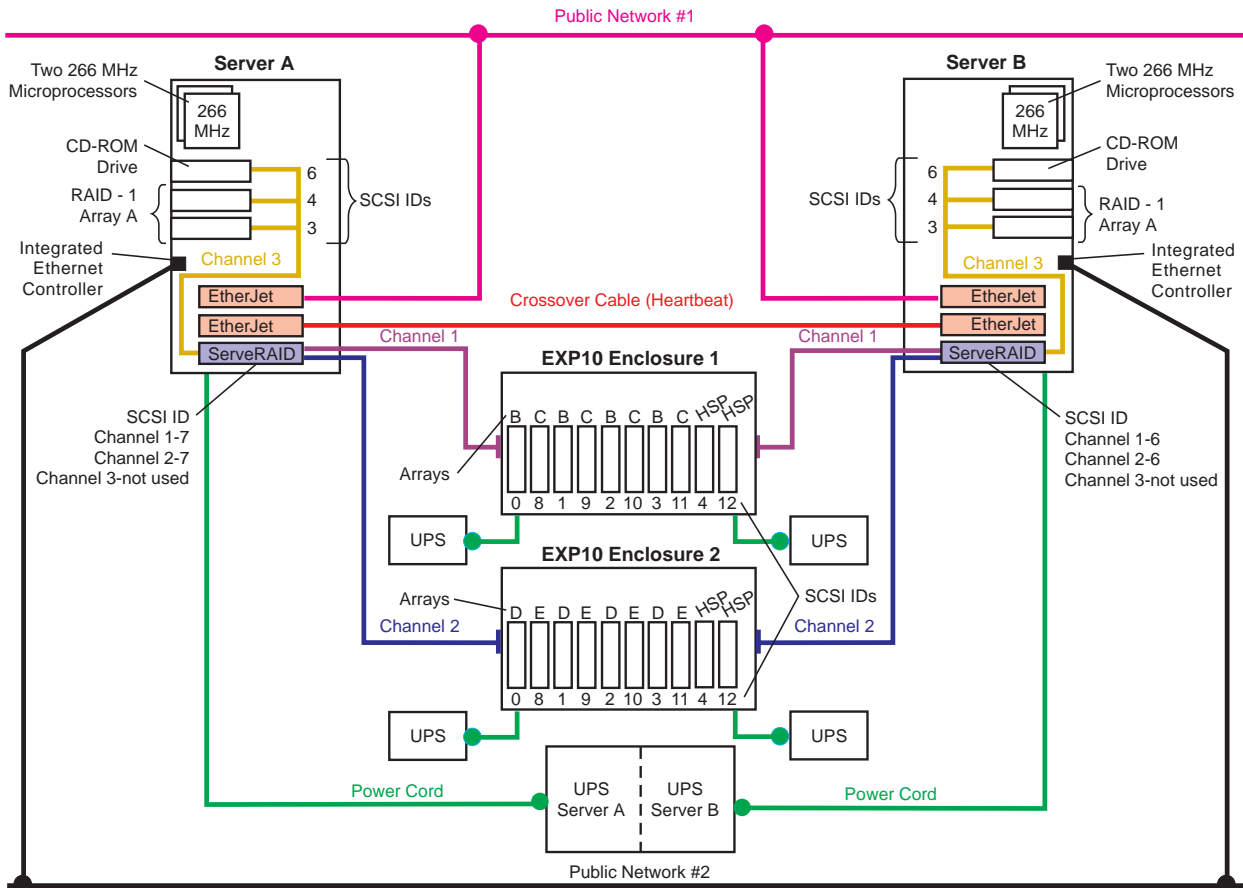
Figure 5. PC Server 325 Rack Cluster Example 2

The capacity of the Netfinity Rack is 42U. Each server occupies 5U and each EXP10 enclosure occupies 3U. You can house this 16U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in one IBM Netfinity Rack or in an industry-standard, 19-inch rack that meets EIA-310-D standards and has a minimum depth of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects two IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. This example shows two separate connections to external, public networks. The servers connect to Public Network 1 using the second IBM 100/10 PCI EtherJet Adapter in each server, and they connect to Public Network 2 using the Ethernet controllers on the system boards. Using the public-network

connections and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

To maintain high availability, the two hard disk drives in each server are defined as RAID level-1 logical drives (Array A) using Channel 3 of the ServeRAID adapters. Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program. The internal SCSI cables remain attached to the CD-ROM drives, but the end connectors that were attached to the SCSI controllers on the system boards are now attached to the Channel 3 connectors on the ServeRAID adapters. The hard disk drive attached to the end connector on the internal SCSI cable in each server has its termination set to Enabled. The other hard disk drive in each server has its termination set to Disabled.

Note: The termination for the CD-ROM drive is permanently set to Disabled. You can not Enable termination on the CD-ROM drive.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1 and 2 of the ServeRAID adapter in Server A are set to SCSI ID 7. Channels 1 and 2 of the ServeRAID adapter in Server B are both set to SCSI ID 6, because they share the same SCSI buses as Channels 1 and 2 of the ServeRAID adapter in Server A. Channel 3 of both ServeRAID adapters connects to the nonshared drives in each server; it is set to SCSI ID 7 to avoid a conflict with the CD-ROM drive, which is set to SCSI ID 6.

The Netfinity EXP10 enclosures each contain ten hot-swap hard disk drives. A SCSI cable (provided with each expansion enclosure) connects the SCSI Bus 1 OUT and SCSI Bus 2 IN connectors on the rear of the enclosures, forming one continuous SCSI bus in each enclosure.

Enclosure 1 contains ten 4.51 GB drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 1 of the ServeRAID adapter in Server A, and the SCSI Bus 2 OUT connector is attached to Channel 1 of the ServeRAID adapter in Server B.

Enclosure 2 contains ten 9.1 GB hot-swap hard disk drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 2 of the ServeRAID adapter in Server A and the SCSI Bus 2 OUT connector is attached to Channel 2 of the ServeRAID adapter in Server B.

Note: To help increase the availability of the shared disks and to enable the serviceability of a failing or offline server, you must use Netfinity EXP10 Auto-Sensing Cables, IBM Part Number 03K9352, to connect clustered servers to Netfinity EXP10 enclosures.

The EXP10 auto-sensing cables contain circuits that can automatically sense the functional status of the server. When the circuitry in an auto-sensing cable detects that the server attached to it is failing or offline, the cable circuitry automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server.

To help maintain high availability, eight of the 4.51 GB drives are grouped into two RAID level-5 logical drives (arrays B and C) in enclosure 1, and eight of the 9.1 GB drives are grouped into two RAID level-5 logical drives (arrays D and E) in enclosure 2. To further increase the availability of the shared disks, each ServeRAID adapter has its own hot-spare (HSP) drives: one 4.51 GB and one 9.1 GB. A hot-spare

drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP10 enclosure. The IDs alternate between low and high addresses, and might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments from left (bay 1) to right (bay 10) are: 0 8 1 9 2 10 3 11 4 12.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the PC Server 325 Rack Cluster Example 2

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

 1. In Server B, use the ServeRAID utility program to change the ServeRAID adapter Channel 3 SCSI ID from 7 to 6.

 2. Install a Third Channel Cable Option on the ServeRAID adapters in both servers.

    Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

 3. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to the external Channel 3 connector on one of the ServeRAID adapters.

 4. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of the ServeRAID adapter in Server A to Channel 3 of the ServeRAID adapter in Server B.

 5. Define two drives in expansion unit 1 as a RAID level-1 logical drive; then, use that logical drive as your quorum drive.

 6. Install an additional ServeRAID adapter in each server; then, connect the nonshared drives in each server to the newly installed adapters.

    It is good practice to maintain the high-availability functions on all drives. However, if you do not require high availability on the drives in the servers, you can connect the drives in the servers to the integrated SCSI controllers on the system boards.

    Note: If you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, be sure to install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the PC Server 325, the PCI slots are scanned in the following order: 3, 2, 1, 6, 5, 4.

Parts List for the PC Server 325 Rack Cluster Example 2

Quantity	Part Number	Description
2	8639-RB0	Rack-ready model of the PC Server 325
2	35201RU	Netfinity EXP10 enclosure
2	94G6474	64 MB, 60 ns, EDO ECC DIMM (one for each server)
2	01K6600	266 MHz Pentium II Microprocessor Upgrade with 512 KB of Level-2 Cache (one for each server)
2	76H3584[24]	IBM ServeRAID II Ultra SCSI Adapter (one for each server)
4	03K9352	Netfinity EXP10 3.0 Meter External Auto-Sensing Cable
4	86H2432	IBM 100/10 PCI EtherJet Adapter (two for each server)
4	Varies[25]	Ethernet cables (to connect the servers to the public network)
1	None[26]	Ethernet Crossover Cable
10	01K7956	4.51 GB Wide Ultra SCSI SCA-2
10	01K7959	9.10 GB Wide Ultra SCSI SCA-2
4	76H2687	Ultrastar 4.51 GB Wide Ultra SCSI (two for each server)
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
1	01K8029	4.3 Meter External 68-pin SCSI Cable (required for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[27]	Uninterruptible Power Supplies

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[24] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[25] Must be purchased separately. Part numbers vary.

[26] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[27] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

Netfinity 5000 Rack Cluster Example

Figure 6 shows a low-cost, high-availability, shared-disk cluster consisting of two rack models of the Netfinity 5000 and two Netfinity EXP15 enclosures. In addition to its standard features, each Netfinity 5000 contains one IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter, one IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter, one IBM 100/10 PCI EtherJet Adapter, one additional 400 MHz microprocessor, one optional 175 Watt redundant power supply, one 256 MB memory kit, and two 9.1 GB hard disk drives. (See "Parts List for the Netfinity 5000 Cluster Example" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID-3H adapters, you also could use ServeRAID II adapters.
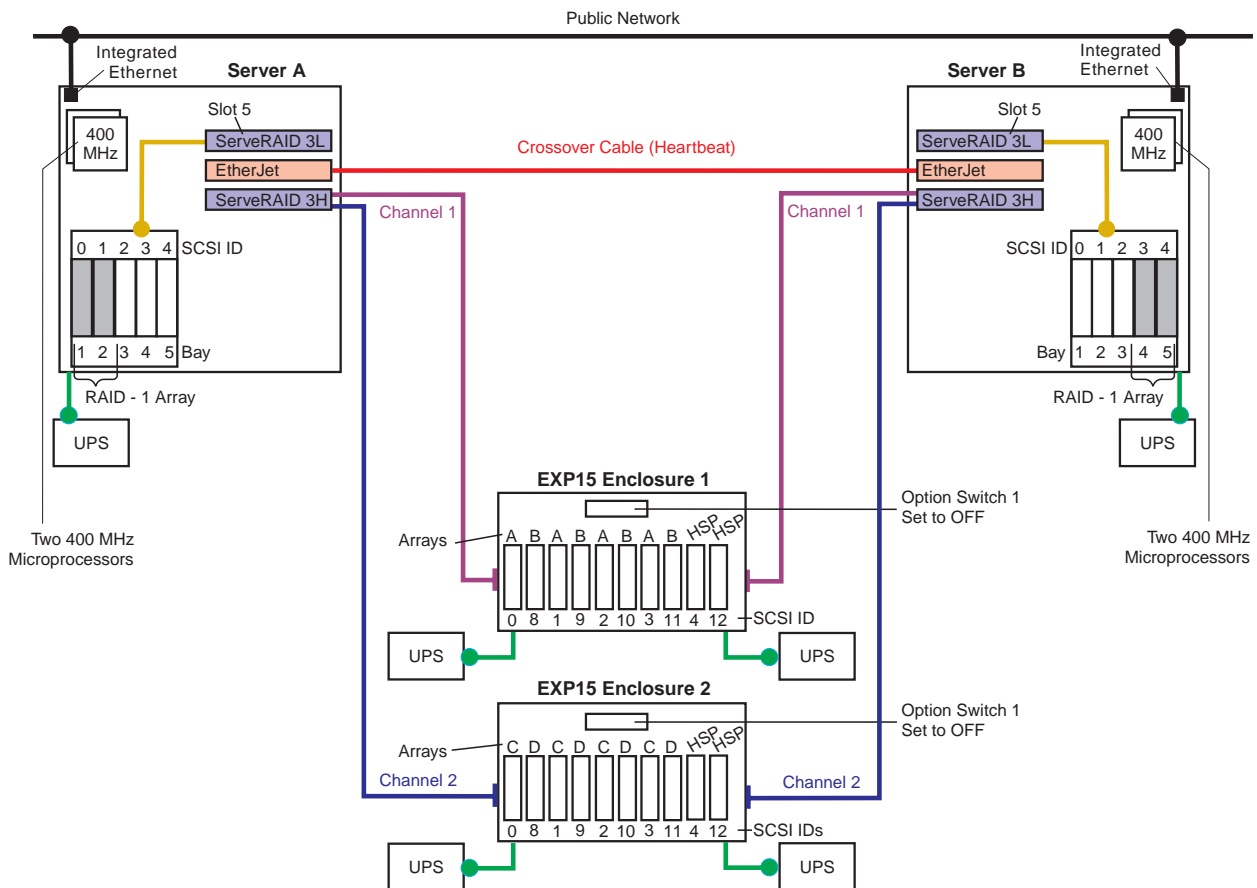
Figure 6. Netfinity 5000 Rack Cluster Example

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects the IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. The servers connect to the public network using the Ethernet controllers on the system boards. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

Server A and Server B are configured identically. To maintain high availability, the two hard disk drives in each server are connected to the single-channel ServeRAID-3L adapters, and they are configured as RAID level-1 logical drives. In each server, the internal SCSI cable that comes attached to the SCSI controller on the system board has been moved from the system-board connector to the internal channel connector on the ServeRAID-3L adapter. Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, the ServeRAID-3L adapter is installed in PCI slot 5.

Note: When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. The Netfinity 5000 has two primary PCI buses: PCI bus 1 and PCI bus 2. Expansion slot 5 is on PCI bus 1, expansion slots 1 through 4 are on PCI bus 2, and the system scans PCI bus 1 (slot 5) first.

Other items in this example that increase the availability and reliability of the servers include the additional memory, microprocessors, and power supplies. Each server comes with 64 MB of memory and supports up to 1 GB of system memory. In this example, the additional 256 MB memory kits bring the total system memory for each server up to 320 MB, and the additional microprocessors enable symmetric multiprocessing for each server. Each server also comes with two, 175 Watt power supplies packaged in one 350 Watt unit. The additional 175 Watt supplies provide N+1 power redundancy for up to 350 Watts for each server.

On both ServeRAID-3H adapters, Channel 3 is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

The maximum storage capacity[29] for each Netfinity EXP15 is 182 GB, using ten 18.2 GB hot-swap drives. However, this example shows ten 9.1 GB hot-swap hard disk drives in each enclosure. To help maintain high availability, the drives are grouped into four RAID level-5 logical drives (arrays A, B, C, and D). To further increase the availability of the shared drives, each ServeRAID-3H adapter has its own hot-spare (HSP) drive. A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

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[28] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[29] This figure represents raw-storage capacity. Several factors influence the actual amount of usable-storage capacity, such as the drive's capacity and the RAID levels assigned.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

Option Switch 1, on the rear of each EXP15 enclosure, is set to the "Off" position, forming one continuous SCSI bus in each enclosure.

For EXP15 Enclosure 1, the Channel 1 connector on the ServeRAID-3H adapter in Server A is connected to the SCSI Bus 1 IN connector, and the Channel 1 connector on the ServeRAID-3H adapter in Server B is connected to the SCSI Bus 2 IN connector.

For EXP15 Enclosure 2, the Channel 2 connector on the ServeRAID-3H adapter in Server A is connected to the SCSI Bus 1 IN connector, and the Channel 2 connector on the ServeRAID-3H adapter in Server B is connected to the SCSI Bus 2 IN connector.

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP15 enclosures. When configured as one continuous SCSI bus, the SCSI IDs alternate between low and high addresses, and might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments for each enclosure from left (bay 1) to right (bay 10) are: 0 8 1 9 2 10 3 11 4 12.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

The capacity of the Netfinity Rack is 42U. Each server occupies 5U and each EXP15 enclosure occupies 3U. You can house this 16U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in IBM Netfinity Racks or in industry-standard, 19-inch racks that meet EIA-310-D standards and have minimum depths of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

Quorum Modifications for the Netfinity 5000 Rack Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. Define two drives in either enclosure as one RAID level-1 logical drive; then, use that logical drive as your quorum drive.

2. In Server B, use the ServeRAID utility program to change the ServeRAID-3H adapter Channel 3 SCSI ID from 7 to 6.

3. In both servers, install the Third Channel Cable Option on the ServeRAID adapters that will connect to the enclosure for the Quorum drive.

   Notes:

   a. The ServeRAID-3H Third Channel Cable option comes packaged with the ServeRAID-3H adapter.

   b. If you want to connect ServeRAID II adapters to the Quorum drive, you must obtain and install the ServeRAID II Third Channel Cable Option, part number 76H5400.

   c. You cannot use ServeRAID-3L adapters for the Quorum link.

4. Using a 4.2 meter cable, IBM Part Number 03K9311, connect Channel 3 of the ServeRAID-3H adapter in Server A to Channel 3 of the ServeRAID-3H adapter in Server B.

Parts List for the Netfinity 5000 Cluster Example

Quantity	Part Number	Description
2	8659-2SY	Rack-ready model of the Netfinity 5000
2	10L5884	400 MHz, 512 KB Level-2 cache microprocessors (one for each server)
2	01K8043	256 MB SDRAM, ECC RDIMM Memory Kit (one for each server)
2	10L7007	175 Watt Redundant Power Supply Option (one for each server)
2	01K7807	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (one for each server)
2	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (one for each server)
2	08L2549	IBM 100/10 PCI EtherJet Adapter (one for each server)
4	01K8053	9.10 GB Wide Ultra SCSI SCA-2 (two for each server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
2	Varies[30]	Ethernet cables (to connect the servers to the public network)
1	None[31]	Ethernet Crossover Cable
2	35202RU	Netfinity EXP15 enclosure
20	01K7959	9.10 GB Wide Ultra SCSI SCA-2 (ten for each enclosure)
4 or 5	03K9311	4.2 Meter External Ultra2 SCSI Cable (These cables connect the ServeRAID-3H adapters to the EXP15 enclosures. One is also required for the quorum-arbitration link when using Microsoft Cluster Server.)
1 or more	Varies[15]	Uninterruptible Power Supplies

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[30] Must be purchased separately. Part numbers vary.

[31] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[32] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

Netfinity 5500 M10 Rack Fibre Channel Cluster Example

Figure 7 shows a high-availability, shared-disk cluster consisting of two rack models of the Netfinity 5500 M10, one Netfinity Fibre Channel Hub, one Netfinity Fibre Channel RAID Controller, and two Netfinity EXP15 enclosures. In addition to its standard features, each Netfinity 5500 M10 contains one Netfinity Fibre Channel Adapter, one IBM 100/10 PCI EtherJet Adapter, one additional 400 MHz microprocessor, one optional 400 Watt redundant power supply, one 512 MB memory kit, and three 9.1 GB hard disk drives. (See "Parts List for the Netfinity 5500 M10 Cluster Example" for a complete list of the components used in this example.)
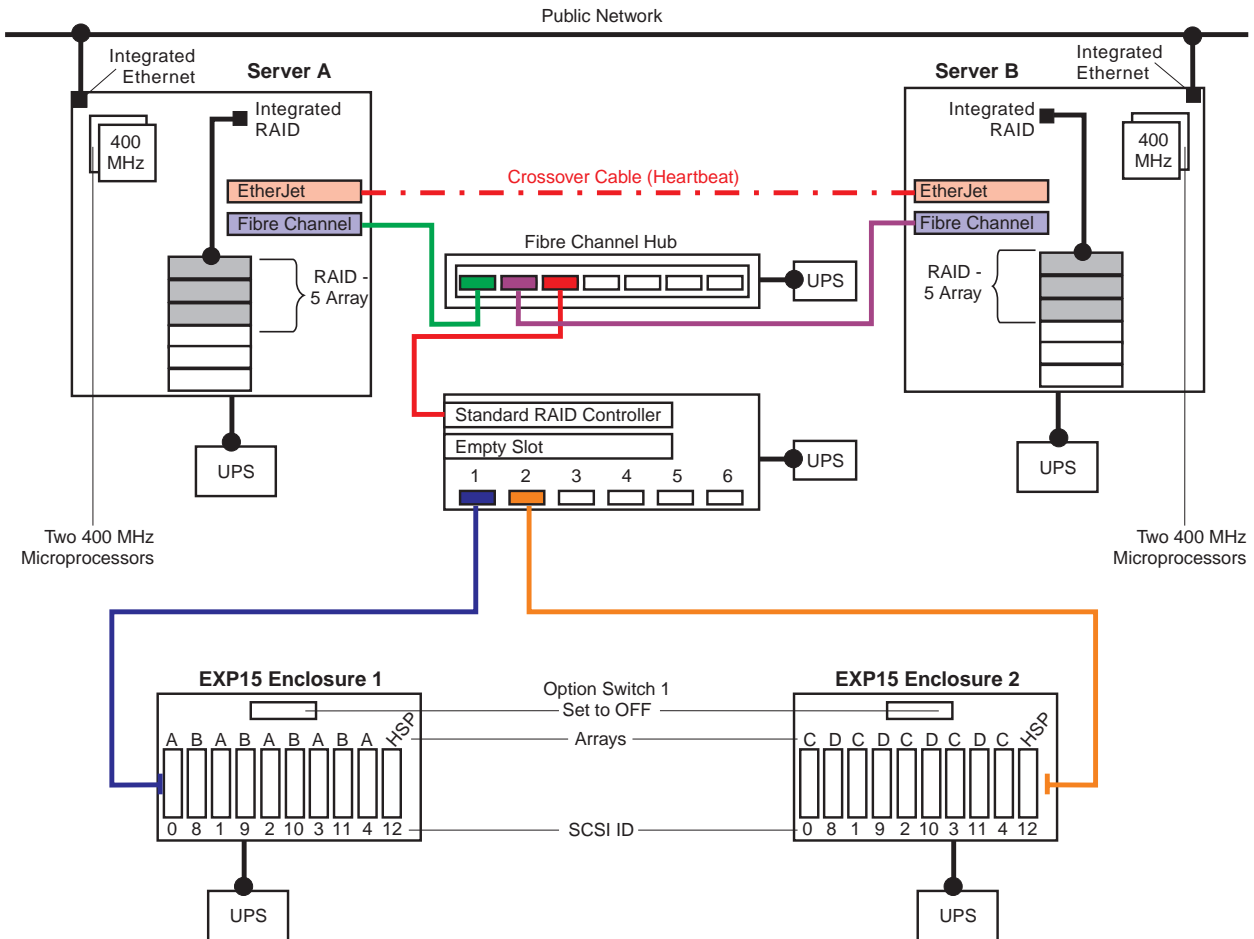
Figure 7. Netfinity 5500 M10 Rack Fibre Channel Cluster Example

The recently announced Netfinity fibre-channel products, such as the IBM Netfinity Fibre Channel RAID Controller, support data transfer speeds of up to 100 MB/sec at a maximum cable length or distance of up to 10 kilometers (6 miles).

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects the IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. The servers connect to the public network using the Ethernet controllers on the system boards. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

2. You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

3. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

Server A and Server B are configured identically. To maintain high availability, the three hard disk drives in each server are defined as RAID level-5 logical drives using the integrated ServeRAID controller on the system board.

Other items in this example that increase the availability and reliability of the servers include the additional memory, microprocessors, and power supplies. Each server comes with 128 MB of memory and supports up to 2 GB of system memory. In this example, the additional 512 MB memory kit brings the total system memory for each server up to 640 MB, and the additional microprocessor enables symmetric multiprocessing for each server. Each server also comes with one, 400 Watt hot-swap power supply, but supports an additional 400 Watt hot-swap supply for power redundancy.

The maximum storage capacity[34] for each Netfinity EXP15 is 182 GB, using ten 18.2 GB hot-swap drives. However, this example shows ten 9.1 GB hot-swap hard disk drives in each enclosure. To help maintain high availability, the drives are grouped into four RAID level-5 logical drives (arrays A, B, C, and D). To further increase the availability of the shared drives, each enclosure has its own hot-spare (HSP) drive.

Option Switch 1, on the rear of the EXP15 enclosures, is set to the "Off" position. This forms one continuous SCSI bus in each enclosure.

The Channel 1 connector on the Fibre Channel RAID Controller unit is connected to the SCSI Bus 1 IN connector on EXP15 Enclosure 1 and the Channel 2 connector on the controller unit is connected to the SCSI Bus 1 IN connector on EXP15 Enclosure 2.

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP15 enclosures. When configured as one continuous SCSI bus, the SCSI IDs alternate between low and high addresses. These alternating IDs might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments for each enclosure from left (bay 1) to right (bay 10) are: 0 8 1 9 2 10 3 11 4 12.

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[33] This figure represents raw-storage capacity. Several factors influence the actual amount of usable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[34] This figure represents raw-storage capacity. Several factors influence the actual amount of usable-storage capacity, such as the drive's capacity and the RAID levels assigned.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

The capacity of the Netfinity Rack is 42U. Each server occupies 8U, each EXP15 enclosure occupies 3U, the Netfinity Fibre Channel Hub occupies 1U, and the Netfinity Fibre Channel RAID Controller unit occupies 4U. You can house this 27U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in IBM Netfinity Racks or in industry-standard, 19-inch racks that meet EIA-310-D standards and have minimum depths of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

Quorum Modifications for the Netfinity 5500 M10 Rack Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration by defining two drives in either enclosure as one RAID level-1 logical drive. Then, use that logical drive as your quorum drive.

Parts List for the Netfinity 5500 M10 Cluster Example

Quantity	Part Number	Description
2	8661-2RY	Rack-ready model of the Netfinity 5500 M10
2	10L5894	400 MHz, 1 MB Level-2 cache microprocessors (one for each server)
2	01K7263	512 MB SDRAM, ECC RDIMM Memory Kit (one for each server)
2	01K7951	400 Watt Redundant Hot-Swap Power Supply (one for each server)
2	08L2549	IBM 100/10 PCI EtherJet Adapter (one for each server)
2	01K7297	Netfinity Fibre Channel Adapter (one for each server)
6	01K8053	9.10 GB Wide Ultra SCSI SCA-2 (three for each server)
2	Varies[35]	Ethernet cables (to connect the servers to the public network)
1	None[36]	Ethernet Crossover Cable
1	35261RU	Netfinity Fibre Channel RAID Controller
1	35231RU	Netfinity Fibre Channel Hub
2	35202RU	Netfinity EXP15 enclosure
20	01K7959	9.10 GB Wide Ultra SCSI SCA-2 (ten for each enclosure)
2	03K9311	4.2 meter External Ultra2 SCSI Cable (from the RAID controller unit to the EXP15 enclosures)
3	03K9606	5 meter fibre-channel cables (to and from the fibre-channel hub)
1 or more	Varies[37]	Uninterruptible Power Supplies

Netfinity 7000 Tower Cluster Example

Figure 8 shows a high-availability, shared-disk cluster consisting of two Netfinity 7000 servers and four 3518 Enterprise Expansion Enclosures.   In addition to its standard features, each Netfinity 7000 contains four 200 MHz Pentium Pro microprocessors with 1 MB of level-2 cache (one microprocessor standard), three IBM ServeRAID II Ultra SCSI Adapters, three IBM 100/10 PCI EtherJet Adapters, four 4.51 GB hot-swap hard disk drives, and three redundant power supplies (two standard). (See "Parts List for the Netfinity 7000 Tower Cluster Example" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.

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[35] Must be purchased separately. Part numbers vary.

[36] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[37] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.
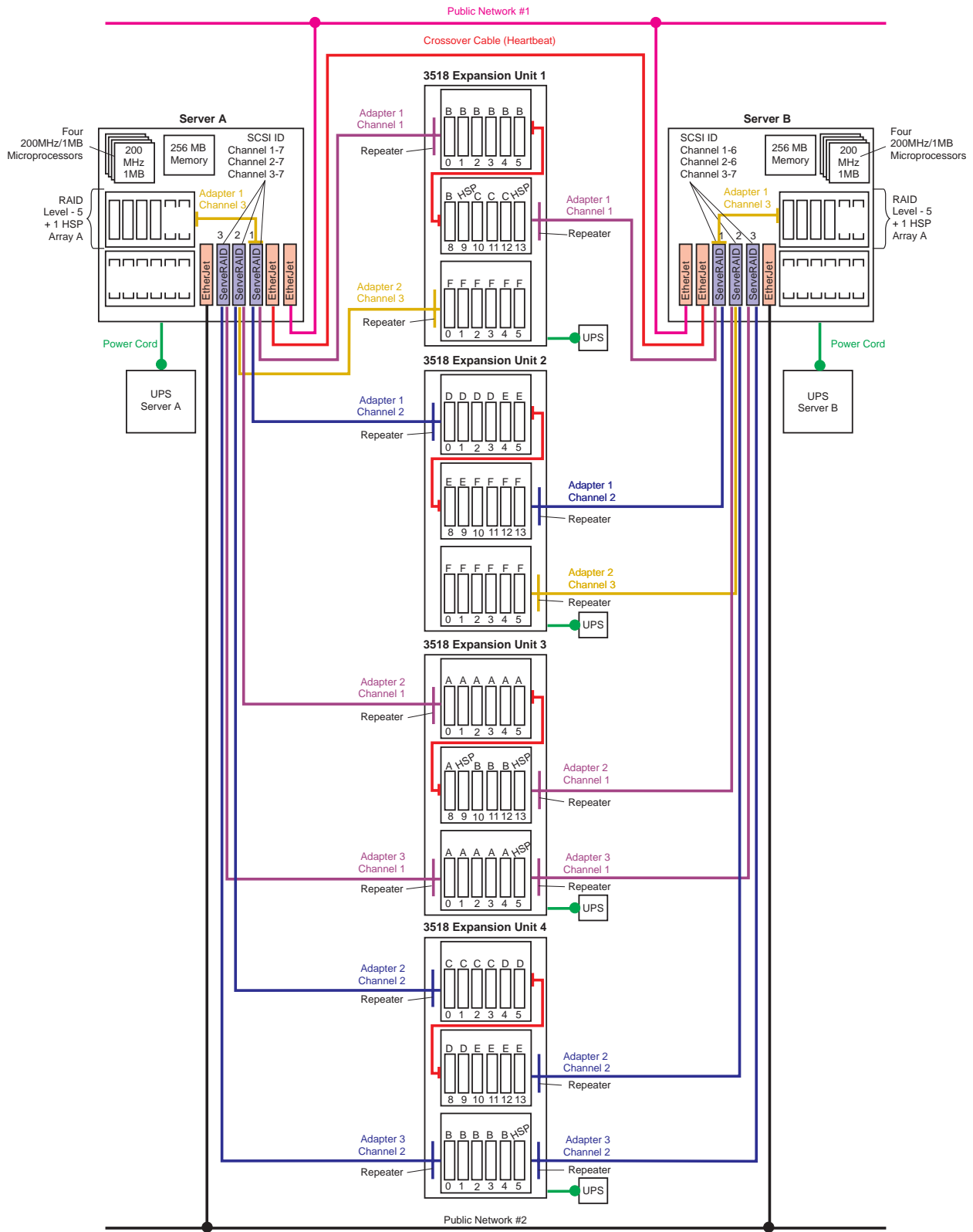
Figure 8. Netfinity 7000 Tower Cluster Example

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects two IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

2. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

Each server also contains two more EtherJet adapters. These adapters provide multiple connections to external networks (in this example, Public Network 1 and Public Network 2). Using the public-network connections and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

In both servers, the internal SCSI cable that connects to the backplane was moved from the Ultra SCSI controller on the system board to the Channel 3 connector on ServeRAID Adapter 1. Then, using Channel 3 of ServeRAID Adapter 1, three of the hard disk drives in each server were defined as RAID level-5 logical drives (Array A). Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program. In addition, this example shows multiple ServeRAID adapters installed in each server. When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the Netfinity 7000, the PCI slots are scanned in the following order: 1, 2, 3, 4, 5, 6. To further increase availability, each server contains a hot-spare (HSP) drive for the internal nonshared array.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1, 2, and 3 of all three ServeRAID adapters in Server A are set to SCSI ID 7. In Server B, Channels 1 and 2 of all three ServeRAID adapters are set to SCSI ID 6, because they share the same SCSI buses as Channels 1 and 2 of the ServeRAID adapters in Server A. Channel 3 of ServeRAID Adapters 1 and 2 in Server B are both set to SCSI ID 7, because they are not connected to any shared disks. Channel 3 of ServeRAID Adapter 3 in each server is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

In addition to the standard features of the 3518 expansion enclosure, each enclosure contains a power-supply upgrade option, two additional backplanes, three or four enhanced SCSI repeaters, one daisy-chain cable, and eighteen 9.1 GB hot-swap hard disk drives. The enhanced SCSI repeaters contain circuits that can automatically sense the functional status of the server. When the SCSI repeater circuitry detects that the server attached to it is failing or offline, the SCSI repeater automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server. In this example, expansion units 1 and 2 have the same basic hardware configuration, and expansion units 3 and 4 have the same basic hardware configurations. However, each expansion unit has unique disk-array configurations.

To help maintain high availability, the 72 hard disk drives in the four 3518 enclosures are defined as 14 RAID level-5 logical drives (notice the array designations above each drive). To further increase the availability of these drives, each ServeRAID adapter has its own hot-spare drive (notice the HSP above 6 of the drives). A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

Both servers share 12 of the 14 arrays; however, Server A has total control of Array A in Bank E of expansion unit 1, and Server B has total control of Array A in Bank E of expansion unit 2.

Note: Installing nonshared drives in a clustered 3518 enclosure is supported only when using the most current enhanced SCSI repeaters. The most current enhanced SCSI repeater is card part number 07L8392, which is provided in option part number 94G7585. Earlier versions of the enhanced repeater are not supported when storing nonshared drives in a clustered 3518 storage enclosure.

In all four enclosures, the Bank D backplane jumpers are set for Bank D and for high addressing (SCSI IDs 8 to 13) and the Bank E backplane jumpers are set for Bank E and for low addressing (SCSI IDs 0 to 5). Cables connect the Bank C and Bank D backplanes, creating one long SCSI bus in each enclosure that can support up to 12 hot-swap drives.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the Netfinity 7000 Tower Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. Define two of the six 9.1 GB drives in Bank E of expansion unit 3 or Bank E of expansion unit 4 as a RAID level-1 logical drive; then, use that logical drive as your quorum drive.

2. In Server B, use the ServeRAID utility program to change the ServeRAID Adapter 3 Channel 3 SCSI ID from 7 to 6.

3. Install the Third Channel Cable Option on Channel 3 of ServeRAID Adapter 2 in both servers.

   Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

4. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to one of the ServeRAID Adapter 2 Channel 3 external connectors.

5. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of ServeRAID Adapter 2 in Server A to Channel 3 of ServeRAID Adapter 2 in Server B.

Parts List for the Netfinity 7000 Tower Cluster Example

Quantity	Part Number	Description
2	8651-TH0	Netfinity 7000 server
6	94G7147	200 MHz Pentium Pro Microprocessor Upgrade with 1 MB of Level-2 Cache (three for each server)
2	94G7150	Netfinity 400 Watt Hot-Swap Redundant Power Supply (one for each server)
8	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap Hard Disk Drive (four for each server)
6	76H3584[38]	IBM ServeRAID II Ultra SCSI Adapter (three for each server)
4	Varies[39]	Ethernet cables (to connect the servers to the public network)
4	3518001	PC Server 3518 Enterprise Storage Expansion Enclosure
72	02K0477	9.1 GB Wide Ultra SCSI Hot-Swap Hard Disk Drive (slim line)
4[40]	94G7584	Shared Disk Convenience Kit Each kit contains the following: • 1 76H2670 Hot-Swap Backplane III • 2 94G7585[41] SCSI-2 Fast/Wide Enhanced Repeaters • 1 94G7593 Power Supply Upgrade II option • 2 86H2432 IBM 100/10 PCI EtherJet Adapters • 2 94G4070 Backplane-to-Backplane cable • 1 70G9876 Expansion Enclosure Backplane Cable • 1 76H0551[42] Ethernet Crossover cable • 2 01K8029 4.3 Meter External 68-pin SCSI Cable
4	76H2670	Hot-Swap Backplane III (in addition to the eight provided in the convenience kits)
6	94G7585	Enhanced SCSI Repeater (in addition to the eight provided in the convenience kits)
6	70G9876	Expansion Enclosure Backplane Cable (in addition to the four provided in the convenience kits)
6 or 7	01K8029	4.3 Meter External 68-pin Cable (in addition to the eight provided in the convenience kits: six required for the example configuration shown and seven required if you are using Microsoft Cluster Server)
0 2 or 4	76H5400	Third Channel Cable Option (to route the ServeRAID II adapter's third channel for external use. Two are required for the example configuration shown, four are required when using this configuration with the modifications for Microsoft Cluster Server, and none are required when using ServeRAID-3H adapters)
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[43]	Uninterruptible Power Supplies

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[38] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[39] Must be purchased separately. Part numbers vary.

[40] If you want to increase the high-availability features of the 3518 expansion enclosure by using the 780 Watt Redundant Power Supply, do not purchase the convenience kits. Instead, purchase the individual components provided in the convenience kits, but replace the Power Supply Upgrade II option with the 780 Watt Redundant Power Supply option, Part Number 94G4701. Also, depending upon your requirements, it might be more cost effective to purchase the required components individually.

[41] The SCSI-2 Enhanced Repeater, Part Number 94G5565, is not supported in cluster configurations.

[42] This cable is not available for separate purchase. This Category 5 cable is designed for point-to-point connections and has RJ-45 connectors on each end.

[43] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

Netfinity 7000 Rack Cluster Example

Figure 9 shows a high-availability, shared-disk cluster consisting of two Netfinity 7000 rack models and four Netfinity EXP10 enclosures. In addition to its standard features, each Netfinity 7000 contains four 200 MHz Pentium Pro microprocessors with 1 MB of level-2 cache (one microprocessor standard), two IBM ServeRAID II Ultra SCSI Adapters, three IBM 100/10 PCI EtherJet Adapters, four 4.51 GB hot-swap hard disk drives, and three redundant power supplies (two standard). (See "Parts List for the Netfinity 7000 Rack Cluster Example" for a complete list of the components used in this example.)

Note: Although this example shows ServeRAID II adapters, you also could use ServeRAID-3H adapters.
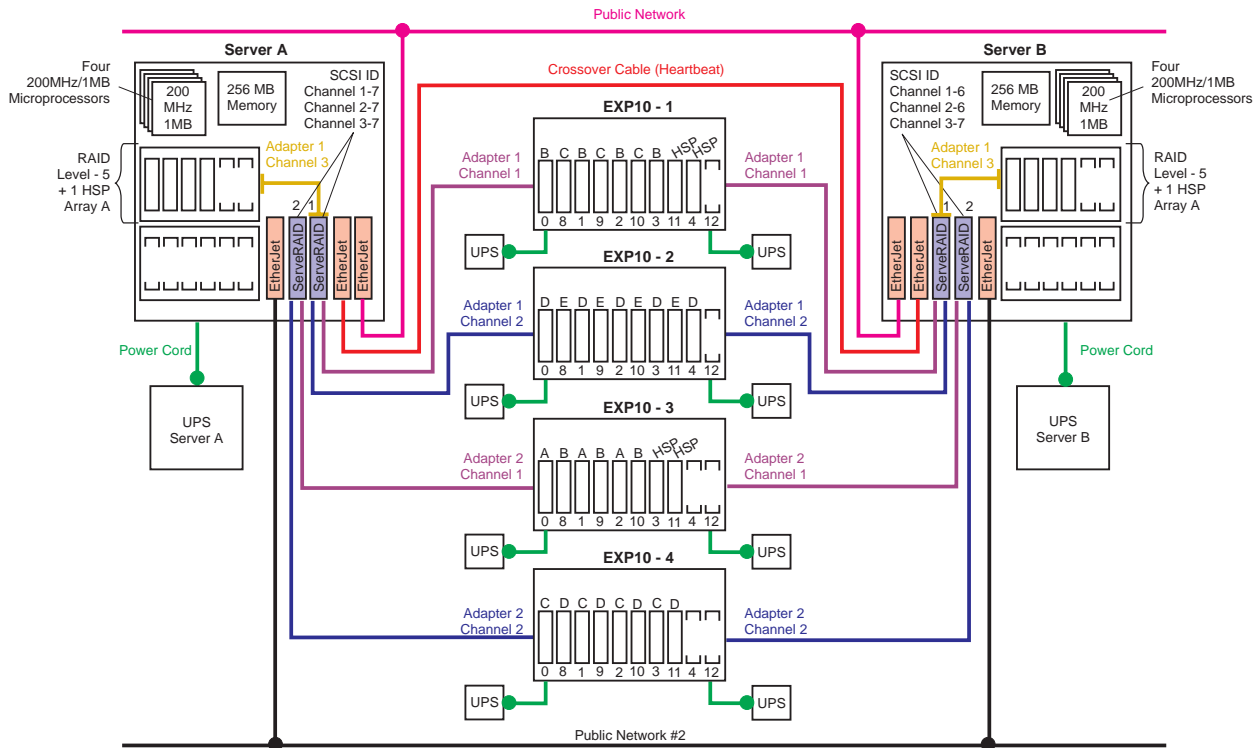
Figure 9. Netfinity 7000 Rack Cluster Example

The capacity of the Netfinity Rack is 42U. Each server occupies 11U and each EXP10 enclosure occupies 3U. You can house this 34U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in IBM Netfinity Racks or in industry-standard, 19-inch racks that meet EIA-310-D standards and have a minimum depth of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

In this example, the server hardware is configured the same as in the Enterprise Tower example, which appears in Figure 8. However, by using the Netfinity EXP10 storage enclosures, the amount of physical space needed to store the cluster decreases significantly, the number of ServeRAID adapters needed to support the cluster decreases by two, and the potential hot-swap storage capacity increases by four 18.2 GB drives. (Each 3518 enclosure can support eighteen 9.10 GB hot-swap drives, and each Netfinity EXP10 enclosure can support ten 18.2 GB hot-swap drives.)

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects two IBM 100/10 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status.

Notes:

1. You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

2. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

Each server also contains two more EtherJet adapters. These adapters provide multiple connections to external networks (in this example, Public Network 1 and Public Network 2). Using the public-network connections and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

In both servers, the internal SCSI cable that connects to the backplane was moved from the Ultra SCSI controller on the system board to the Channel 3 connector on ServeRAID Adapter 1. Then, using Channel 3 of ServeRAID Adapter 1, three of the hard disk drives in each server were defined as RAID level-5 logical drives (Array A). Because these nonshared drives store the operating system and shared-disk clustering software needed during startup, these drives were defined *first* using the ServeRAID configuration program. In addition, this example shows multiple ServeRAID adapters installed in each server. When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the Netfinity 7000, the PCI slots are scanned in the following order: 1, 2, 3, 4, 5, 6. To further increase availability, each server contains a hot-spare (HSP) drive for the internal nonshared array. A hot-spare drive is a disk drive that is defined for automatic use in the event of a drive failure. If a physical drive fails and it is part of a RAID level-1 or RAID level-5 logical drive, the ServeRAID adapter will automatically start to rebuild the data on the hot-spare drive.

Note: ServeRAID adapters cannot share hot-spare drives. To maintain high availability and enable the automatic-rebuild feature, you must define a hot-spare drive for each ServeRAID adapter.

The only difference between the hardware configuration of Server A and the hardware configuration of Server B is the SCSI ID settings for the ServeRAID adapters. Channels 1, 2, and 3 of both ServeRAID adapters in Server A are set to SCSI ID 7. In Server B, Channels 1 and 2 of both ServeRAID adapters are set to SCSI ID 6, because they share the same SCSI buses as Channels 1 and 2 of the ServeRAID adapters in Server A. Channel 3 of ServeRAID Adapter 1 in Server B is set to SCSI ID 7, because it is not connected to any shared disks. Channel 3 of ServeRAID Adapter 2 in each server is available for use as a quorum-arbitration link with the Microsoft Cluster Server software, or for future expansion with the Vinca clustering software.

In addition to the standard features of the Netfinity EXP10, the storage enclosures each contain eight or nine hot-swap hard disk drives.

A SCSI cable (provided with each expansion enclosure) connects the SCSI Bus 1 OUT and SCSI Bus 2 IN connectors on the rear of the enclosures, forming one continuous SCSI bus in each enclosure.

Enclosure 1 contains nine 9.1 GB drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 1 of ServeRAID Adapter 1 in Server A, and the SCSI Bus 2 OUT connector is attached to Channel 1 of ServeRAID Adapter 1 in Server B.

Enclosure 2 also contains nine 9.1 GB drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 2 of ServeRAID Adapter 1 in Server A, and the SCSI Bus 2 OUT connector is attached to Channel 2 of ServeRAID Adapter 1 in Server B.

Enclosure 3 contains eight 9.1 GB drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 1 of ServeRAID Adapter 2 in Server A, and the SCSI Bus 2 OUT connector is attached to Channel 1 of ServeRAID Adapter 2 in Server B.

Enclosure 4 also contains eight 9.1 GB drives. Using auto-sensing cables, the SCSI Bus 1 IN connector is attached to Channel 2 of ServeRAID Adapter 2 in Server A, and the SCSI Bus 2 OUT connector is attached to Channel 2 of ServeRAID Adapter 2 in Server B.

Note: To help increase the availability of the shared disks and to enable the serviceability of a failing or offline server, you must use Netfinity EXP10 Auto-Sensing Cables, IBM Part Number 03K9352, to connect clustered servers to Netfinity EXP10 enclosures.

The EXP10 auto-sensing cables contain circuits that can automatically sense the functional status of the server. When the circuitry in an auto-sensing cable detects that the server attached to it is failing or offline, the cable circuitry automatically enables termination for that end of the SCSI bus. This helps increase the availability of the shared disks and enables the serviceability of the failing or offline server.

To help maintain high availability, the 34 hard disk drives in the four EXP10 enclosures are defined as eight, shared, RAID level-5 logical drives (notice the array designations of A, B, C, D, or E above each drive). To further increase the availability of these drives, each ServeRAID adapter has its own hot-spare drive (notice the HSP above four of the drives).

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP10 enclosures. The IDs alternate between low and high addresses, and might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments from left (bay 1) to right (bay 10) are: 0 8 1 9 2 10 3 11 4 12.

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

Quorum Modifications for the Netfinity 7000 Rack Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration as follows:

1. Install two 4.5 GB drives in expansion unit 3; then, define the two drives as one RAID level-1 logical drive that you can use as your quorum drive.

2. In Server B, use the ServeRAID utility program to change the ServeRAID Adapter 2 Channel 3 SCSI ID from 7 to 6.

3. Install a Third Channel Cable Option on Channel 3 of ServeRAID Adapter 2 in both servers.

   Note: The part number for the ServeRAID II Third Channel Cable option is 76H5400. If you are connecting ServeRAID-3H adapters to the Quorum drive, install the Third Channel Cable option provided with the ServeRAID-3H adapter.

4. Attach an 8-mm to 68-pin converter, IBM Part Number 01K8017, to one of the ServeRAID Adapter 2 Channel 3 external connectors.

5. Using a 4.3 meter cable, IBM Part Number 01K8029, connect Channel 3 of ServeRAID Adapter 2 in Server A to Channel 3 of ServeRAID Adapter 2 in Server B.

Parts List for the Netfinity 7000 Rack Cluster Example

Quantity	Part Number	Description
2	8651-RH0	Netfinity 7000 rack-ready model
6	94G7147	200 MHz Pentium Pro Microprocessor Upgrade with 1 MB of Level-2 Cache (three for each server)
2	94G7150	Netfinity 400 Watt Hot-Swap Redundant Power Supply (one for each server)
8	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap Hard Disk Drive (four for each server)
4	76H3584[44]	IBM ServeRAID II Ultra SCSI Adapter (two for each server)
6	86H2432	IBM 100/10 PCI EtherJet Adapter (three for each server)
4	Varies[45]	Ethernet cables (to connect the servers to the public network)
1	None[46]	Ethernet Crossover Cable
4	35201RU	Netfinity EXP10 enclosures
8	03K9352	Netfinity EXP10 3.0 Meter External Auto-Sensing Cable
34	01K7959	9.10 GB Wide Ultra SCSI SCA-2
1	01K8017	The 8-mm to 68-pin Converter Option (required for the quorum-arbitration link when using Microsoft Cluster Server)
2	76H5400	Third Channel Cable Option (required to route the ServeRAID II adapter's third channel for external use, such as for the quorum-arbitration link when using Microsoft Cluster Server)
1	01K8029	4.3 Meter External 68-pin SCSI Cable (required for the quorum-arbitration link when using Microsoft Cluster Server)
1 or more	Varies[47]	Uninterruptible Power Supplies

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[44] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[45] Must be purchased separately. Part numbers vary.

[46] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[47] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

Netfinity 7000 M10 Rack Fibre Channel Cluster Example

Figure 10 shows a very robust high-availability, shared-disk cluster consisting of two rack models of the recently announced Netfinity 7000 M10, two Netfinity Fibre Channel Hubs, one Netfinity Fibre Channel RAID Controller unit with a Netfinity Optional Failsafe RAID Controller installed, and three Netfinity EXP15 expansion enclosures.
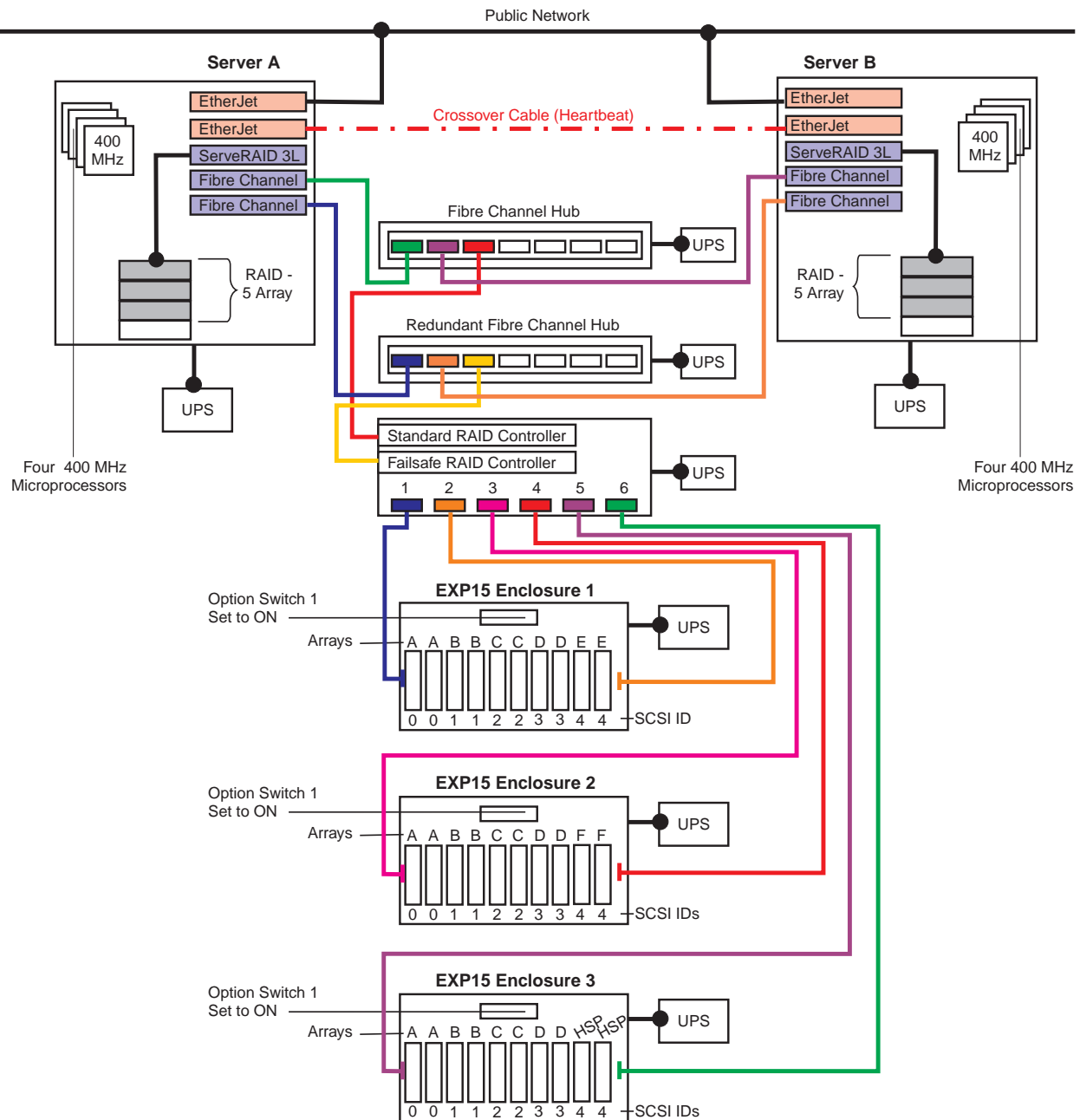

Figure 10. Netfinity 7000 M10 Rack Fibre Channel Cluster Example

In addition to its standard features, each Netfinity 7000 M10 contains two Netfinity Fibre Channel Adapters, two IBM 10/100 PCI EtherJet Adapters, one IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter, three additional 400 MHz microprocessors, one optional 400 Watt redundant power supply, three 256 MB memory kits, and three 9.1 GB hard disk drives. (See "Parts List for the Netfinity 7000 M10 Cluster Example" for a complete list of the components used in this example.)

The recently announced Netfinity fibre-channel products, such as the IBM Netfinity Fibre Channel RAID Controller, support data transfer speeds of up to 100 MB/sec at a maximum cable length or distance of up to 10 kilometers (6 miles).

The network-crossover cable, sometimes referred to as the cluster's *heartbeat*, provides the dedicated, point-to-point communication link between the servers. This cable connects two of the IBM 10/100 PCI EtherJet Adapters (one in each server) and enables the servers to continuously monitor each other's functional status. The other two EtherJet adapters (one in each server) are used to connect the servers to the public network. Using the public-network connection and the dedicated heartbeat link together ensures that a single network-hardware failure will not initiate a failover situation.

Notes:

  1. You *must* use IBM 10/100 PCI EtherJet Adapters for the cluster's heartbeat connection.

  2. You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

Server A and Server B are configured identically. To maintain high availability, the three hard disk drives in each server are connected to the single-channel ServeRAID-3L adapters, and they are configured as RAID level-5 logical drives. In each server, the internal SCSI cable that comes attached to the SCSI controller on the system board has been moved from the system-board connector to the internal channel connector on the ServeRAID-3L adapter. These nonshared drives store the operating system and shared-disk clustering software needed during startup.

Note: If you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, be sure to install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the Netfinity 7000 M10, the PCI slots are scanned in the following order: PCI bus A with 64-bit expansion slots 1, 2, 3, 4, and 5; PCI bus B with 32-bit expansion slots 6, 7, 8, 9, and 10; then PCI bus C with 32-bit expansion slots 11 and 12.

Other items in this example that increase the availability and reliability of this sample cluster include the additional memory, additional microprocessors, redundant power supplies, redundant fibre-channel adapters, redundant fibre-channel hubs, and the Netfinity Failsafe Fibre Channel RAID Controller. Each server comes with 256 MB of memory and supports up to 8 GB of system memory. In this example, the three additional 256 MB memory kits bring the total system memory for each server up to 1 GB, and the additional three microprocessors enable four-way, symmetric multiprocessing. Each server also comes with two, 400 Watt hot-swap power supplies. Adding the third, 400 Watt hot-swap power supply provides power redundancy. In addition, the Optional Failsafe RAID Controller provides redundant protection in the unlikely event of a Netfinity Fibre Channel RAID Controller failure.

This sample configuration also shows the maximum capacity of ten, 18.2 GB drives in each Netfinity EXP15 enclosure, which provides a potential of 540 GB of raw storage capacity[49]. Although you could

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[48] This figure represents raw-storage capacity. Several factors influence the actual amount of usable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[49] This figure represents raw-storage capacity. Several factors influence the actual amount of usable-storage capacity, such as the drive's capacity and the RAID levels assigned.

define these drives in many different ways, this example shows two drives in enclosure 3 defined as hot-spare (HSP) drives and the 28 remaining drives grouped into six arrays.

To help maintain high availability, 24 of the drives are equally grouped into four RAID level-5 logical drives (arrays A, B, C, and D). The remaining four drives are equally grouped into two RAID level-1 logical drives (arrays E and F).

Option Switch 1 on the rear of each EXP15 enclosure is set to the "On" position, forming two independent SCSI buses in each enclosure.

The Channel 1 connector on the Fibre Channel RAID Controller unit is connected to the SCSI Bus 1 IN connector on EXP15 Enclosure 1; the Channel 2 connector on the controller unit is connected to the SCSI Bus 2 IN connector on EXP15 Enclosure 1; the Channel 3 connector on the Fibre Channel RAID Controller unit is connected to the SCSI Bus 1 IN connector on EXP15 Enclosure 2; the Channel 4 connector on the controller unit is connected to the SCSI Bus 2 IN connector on EXP15 Enclosure 2; the Channel 5 connector on the Fibre Channel RAID Controller unit is connected to the SCSI Bus 1 IN connector on EXP15 Enclosure 3; and finally, the Channel 6 connector on the controller unit is connected to the SCSI Bus 2 IN connector on EXP15 Enclosure 3.

The SCSI ID assignments for the shared hot-swap drives are controlled by the backplanes inside the Netfinity EXP15 enclosures. When configured as two independent SCSI buses, the SCSI IDs are repetitive and might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. In this example configuration, the SCSI ID assignments for each enclosure from left (bay 1) to right (bay 10) are: 0 0 1 1 2 2 3 3 4 4.

The level of redundancy provided in this configuration starts with the dual fibre-channel adapters in each server. By installing two fibre-channel adapters in each server and connecting them as shown to the two redundant fibre-channel hubs, both servers have equal access to the fibre-channel RAID controllers. This increases the availability of the shared drives and eliminates having any single points of failure. In addition, both RAID controllers have equal access to the drives in the EXP15 enclosures. The drives are distributed across the six independent SCSI buses (two in each EXP15 enclosure) as shown in the following table.

SCSI Bus	Drive 1	Drive 2	Drive 3	Drive 4	Drive 5
Bus 1	Array A	Array B	Array C	Array D	Array E
Bus 2	Array A	Array B	Array C	Array D	Array E
Bus 3	Array A	Array B	Array C	Array D	Array F
Bus 4	Array A	Array B	Array C	Array D	Array F
Bus 5	Array A	Array B	Array C	Array D	Hot Spare
Bus 6	Array A	Array B	Array C	Array D	Hot Spare

Ideally, the servers and storage enclosures are connected to different electrical circuits; however, this is rarely possible. To help prevent the loss of data and to maintain the availability of the shared disks during a power outage or power fluctuation, always connect the servers and expansion enclosures to uninterruptible power supplies (UPS).

The capacity of the Netfinity Rack is 42U. Each server occupies 11U, each EXP15 enclosure occupies 3U, each Netfinity Fibre Channel Hub occupies 1U, and the Netfinity Fibre Channel RAID Controller unit occupies 4U. You can house this 37U cluster and its support devices (such as console, keyboard, and uninterruptible power supplies) in IBM Netfinity Racks or in industry-standard, 19-inch racks that meet EIA-310-D standards and have minimum depths of 71.12 cm (28 inches). (See "Selecting the Rack Enclosures" for more information.)

Quorum Modifications for the Netfinity 7000 M10 Rack Cluster Example

If you want to use the Microsoft Cluster Server program, you can modify this example configuration by defining two drives in any enclosure as a RAID level-1 logical drive; then, use that logical drive as your quorum drive. In this example, you could use Array E or Array F as the quorum drive.

Parts List for the Netfinity 7000 M10 Cluster Example

Quantity	Part Number	Description
2	8680-2RU	Rack-ready model of the Netfinity 7000 M10
6	01K8007	400 MHz, 1 MB Level-2 cache microprocessors (three for each server)
6	01K8044	256 MB SDRAM, ECC RDIMM Memory Kit (three for each server)
2	01K7951	400 Watt Redundant Hot-Swap Power Supply (one for each server)
4	08L2549	IBM 10/100 PCI EtherJet Adapter (two for each server)
4	01K7297	Netfinity Fibre Channel Adapter (two for each server)
2	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (one for each server)
6	01K8054	9.10 GB 10K Wide Ultra SCSI SCA-2 (three for each server)
2	Varies[50]	Ethernet cables (to connect the servers to the public network)
1	None[51]	Ethernet Crossover Cable
1	35261RU	Netfinity Fibre Channel RAID Controller
1	01K7296	Optional Failsafe RAID Controller
2	35231RU	Netfinity Fibre Channel Hub
3	35202RU	Netfinity EXP15 enclosure
30	01K8501	18.2 GB Wide Ultra SCSI SCA-2 (ten for each enclosure)
6	03K9311	4.2 meter External Ultra2 SCSI cable (from the RAID controller unit to the EXP15 enclosures)
6	03K9606	5 meter fibre-channel cables (to and from the fibre-channel hubs)
1 or more	Varies[52]	Uninterruptible Power Supplies

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[50] Must be purchased separately. Part numbers vary.

[51] This cable is provided in the Netfinity Cluster Pack by Vinca. If you are not using the cluster pack, you must purchase this Category 5 cable from an outside source. The cable must be designed for point-to-point connections and must have RJ-45 connectors on each end.

[52] See "Selecting Servers and Enclosures" for information about the uninterruptible power supply options available for the servers, storage enclosures, and rack enclosures.

Selecting Servers and Enclosures

This section contains descriptions of IBM servers, storage enclosures, and optional devices that you can use to configure a shared-disk cluster. This section also contains some tips to help make the task of configuring your cluster a little easier.

The hardware needed to configure a dual-node, high-availability, shared-disk cluster generally consists of the following basic elements:

- Two identical (or very similar) servers

- Two or more RAID controllers of the same type[53]

- One or more storage expansion enclosures

- Eight or more hard disk drives (two local drives in each server and a minimum of four shared drives of the same capacity in the expansion enclosure)

- Two or more IBM 100/10 PCI EtherJet Adapters or IBM 10/100 PCI EtherJet Adapters[54] (one in each server to provide the dedicated link between the servers, and additional network adapters to connect the servers to the public network)

  Note: Some server models have integrated Ethernet controllers, which you can use to connect the servers to the public network.

- A variety of cables to connect the clustering elements together

- Uninterruptible power supplies (UPS) to keep the servers and expansion enclosures available, should a power fluctuation or outage occur

- Additional microprocessors for the servers, as required

- Additional memory for the servers, as required

Together, these basic elements provide the flexibility you need to design a dual-node cluster that will meet both your current and future needs.

This section does not provide information about all IBM PC Server and Netfinity products available for clustering. To obtain information about earlier PC Server models and other products that IBM has tested in a clustered environment, visit one or more of the following World Wide Web pages:

```
http://www.pc.ibm.com
http://www.pc.ibm.com/support
http://www.pc.ibm.com/us/options/
http://www.pc.ibm.com/us/netfinity/
http://www.pc.ibm.com/us/netfinity/clustering.html
```

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[53] The cluster software packages for the shared-disk cluster examples described in this reference were designed and tested for use with the high-availability functions provided by the IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter, the IBM ServeRAID II Ultra SCSI Adapter, and the IBM Netfinity Fibre Channel RAID Controller.

[54] The shared-disk cluster packages require that you use IBM 100/10 or 10/100 PCI EtherJet Adapters for the dedicated link between the two servers.

Selecting the Servers

This section contains descriptions of the IBM PC Server 325, PC Server 330, Netfinity 5000, Netfinity 5500, Netfinity 5500 M10, Netfinity 7000, and Netfinity 7000 M10 models. This section also contains optional-device information and configuration tips for these systems.

To help you determine the server requirements for your shared-disk cluster, consider the following:

- **How much space is required?**
  You can reduce the amount of floor space required for the cluster by using rack-mountable hardware. IBM offers industry-standard rack enclosures that can accommodate multiple servers and multiple storage enclosures. IBM also offers rack-ready Netfinity and PC Server models.

- **How much distance is allowed between the clustered servers?**
  The allowable distance between the clustered servers depends upon the type of IBM RAID controller and cabling being used.

  - The recently announced Netfinity fibre-channel products, such as the IBM Netfinity Fibre Channel RAID Controller, support data transfer speeds of up to 100 MB/sec at a maximum cable length or distance of up to 10 kilometers (6 miles).
  - The SCSI-3 compliant RAID controllers, such as the IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter and the IBM Netfinity Fibre Channel RAID Controller, default to low voltage differential (LVD) signaling. These configurations can use any external cable lengths offered by IBM for a clustered environment.
  - The SCSI-2 compliant RAID controllers, such as the IBM ServeRAID II Ultra SCSI Adapter, are limited to a maximum of 2 meters of cable to operate at UltraSCSI speeds (40MB/sec), or a maximum of 6 meters of cable to operate at Fast SCSI speeds (20 MB/sec).

- **How much local disk storage is required in each server?**
  Each server requires a minimum of one local hard disk drive with a capacity large enough to store the operating system and shared-disk clustering software. However, since one of the primary objectives of shared-disk clusters is increased availability, you should consider installing more than one hard disk drive in each server and configuring the drives into redundant array of independent disks (RAID) level-1 or RAID level-5 arrays. The maximum local disk storage that you can use will depend on the server models, hard disk drives, and RAID level that you select.

- **How many PCI expansion slots are required?**
  The shared-disk cluster requires two or three PCI expansion slots in each server: one for the ServeRAID or fibre-channel adapter, one for the 100/10 or 10/100 PCI EtherJet adapter (the cluster's heartbeat), and one for the communications adapter that connects each server to the public network.

  All of the Netfinity and PC Server models have a minimum of five PCI expansion slots. In addition, some models have an integrated Ethernet controller, which you can use to connect the servers to the public network.

- **How much system memory is required in each server?**

  The amount of system memory required to maintain performance depends on the type of application software running on the servers and the type of data being stored on the shared disks.

  The amount of system memory that you can install depends on the server model. The PC Server 325 and 330 Pentium II 233, 266, and 300 MHz models support up to 512 MB of ECC system memory; the PC Server 325 and 330 Pentium II 333 MHz models, the PC Server 330 Pentium Pro model, and all Netfinity 5000 and 5500 Pentium II models support up to 1 GB of ECC system memory; all Netfinity 5500 M10 Pentium II Xeon models support up to 2 GB of ECC system memory; all Netfinity 7000 Pentium Pro models support up to 4 GB of ECC system memory; and, all Netfinity 7000 M10 Pentium II Xeon models support up to 8 GB of ECC system memory.

PC Server 325 Standard Features

The following table provides basic information about the PC Server 325 models. IBM also tested earlier models of the PC Server 325 in clustered environments. You can obtain information about earlier models and the optional devices supported on those models at the following World Wide Web address: `http://www.pc.ibm.com/us/netfinity/`

PC Server 325	8639-PT0	8639-PTW	8639-PB0	8639-RB0	8639-1RY	8639-2RY
Form Factor	Tower	Tower	Tower	Rack[55] (5U)[56]	Rack[55] (5U)[56]	Rack[55] (5U)[56]
Microprocessor[57]	233 MHz	233 MHz	266 MHz	266 MHz	300 MHz	333 MHz
Level-2 Cache	All six models have 512 KB of level-2 cache.					
SMP[58]	All six models support 2-way SMP.					
Memory EDO ECC (standard/maximum)	32/512 MB	32/512 MB	64/512 MB	64/512 MB	64/512 MB	64/1024 MB
Bus Architecture	All six models support PCI/ISA bus architectures.					
PCI Disk Controller[59]	All six models have Wide Ultra SCSI PCI disk controllers.					
I/O Slots[60]	All six models have 4 PCI and 2 shared PCI/ISA slots.					
Diskette Drive	All six models have a 3.5 in., 1.44 MB diskette drive in Bay 3.					
CD-ROM Drive	All six models have an 8X SCSI CD-ROM drive in Bay 2.					
Hard Disk Drives (standard)	0	1 x 4.5 GB	0	0	0	0
3.5-inch Drive Bays (empty)	4	3	4	4	4	4
5.25-inch Drive Bays	All six models have one empty 5.25-inch drive bay.					
Power Supply	All six models have one 250 Watt power supply.					
I/O Ports	All six models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, and 1 RJ-45 10/100 Ethernet ports.					

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[55] For use with the IBM Netfinity Rack (9306900) or an industry-standard, 19-inch rack that meets EIA-310-D standards with a minimum depth of 28 inches.

[56] 1U is 44.45 mm (1.75 inches).

[57] Intel Pentium II microprocessor.

[58] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[59] This integrated Ultra SCSI controller has two 68-pin connectors (one internal and one external), and it supports up to fifteen Wide Ultra SCSI devices.

[60] Model 2RY comes with an IBM Systems Management Adapter preinstalled in PCI slot 4.

Optional Devices Supported on the PC Server 325

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Conversion Kit	94G5695	PC Server 325 Tower to Rack Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Hard Disk Drive	76H5815[61]	IBM Ultrastar 2ES 4.33 GB Wide Ultra SCSI
Hard Disk Drive	01K1327	IBM 4.5 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	76H0945	IBM Ultrastar 2XP 4.51 GB Fast/Wide SCSI-2
Hard Disk Drive	76H2687	IBM Ultrastar 2XP 4.51 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	01K1328	IBM 9.1 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	76H2689	IBM Ultrastar 2XP 9.1 GB Wide Ultra SCSI (half high)
Memory	94G6473	32 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G6474	64 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G6475	128 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G7079	256 MB, 60 ns, EDO ECC DIMM (3.3V)
Microprocessor Upgrade	01K6599	233 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	01K6600	266 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	10L5886	300 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	01K8025	333 MHz Pentium II with 512KB Level-2 cache
Monitor	654000x[62]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[62]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654600x[62]	G52 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[62]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65460Ax[62]	G54 15-inch Color Monitor, white (13.7-inch image size)
Monitor	65464Ax[62]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)
Monitor	654700x[62]	G72 17-inch Color Monitor, white (15.7-inch image size)
Monitor	654740x[62]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65470Ax[62]	G74 17-inch Color Monitor, white (15.9-inch image size)
Monitor	65474Ax[62]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	86H2432	IBM 100/10 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[63]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)

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[61] Not supported when attached to a ServeRAID controller.

[62] The "x" varies by geographic location.

[63] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[64] Requires 68-pin to 50-pin converter, IBM Part Number 32G3925.

[65] Comes with a 68-pin to 50-pin converter and required bezels.

[66] All models except models 1RY and 2RY require this terminator when no internal hard disk drives are installed. Models 1RY and 2RY come with a self-terminating cable.

[67] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
SCSI Cable	70G9857	Fast/Wide to Fast/Wide External SCSI Cable
SCSI Cable	70G9858	Fast/Wide to Fast External SCSI Cable
Security	94G7526	Security Cover Kit and Cable Option
Systems Management	94G7578	Advanced Systems Management Adapter
Tape Drive	76H0485	20/40 GB 8-mm SCSI Tape Drive, white
Tape Drive	01K1325	20/40 GB 8-mm SCSI Tape Drive, black
Tape Drive	06H9716[64]	TR4 4/8 GB Internal Tape Drive
Tape Drive	01K1319[65]	10/20 GB NS Internal Tape Drive
Tape Drive	01K1282[65]	12/24 GB DDS/3 4mm Internal Tape Drive
Terminator	94G7587[66]	Active terminator for the internal SCSI cable.
UPS	94G3134[67]	APC Smart-UPS 700 (20 minute runtime at 210 Volt Amps)
UPS	94G3135[67]	APC Smart-UPS 1000 (36 minute runtime at 210 Volt Amps)
UPS	94G3136[67]	APC Smart-UPS 1400 (57 minute runtime at 210 Volt Amps)
UPS	94G6674[67]	APC Smart-UPS 1400 RMB (41 minute runtime at 210 Volt Amps)
UPS	94G6676[67]	APC Smart-UPS 3000 RMB (110 minute runtime at 210 Volt Amps)
Video Memory	76H0238	Video Memory Upgrade (1 MB)

Configuration Tips for the PC Server 325

- You cannot use the CD-ROM drive to terminate the internal SCSI bus. Termination for the CD-ROM drive is controlled by the SCSI device attached to the last connector on the internal SCSI cable.

  If you are not installing an internal hard disk drive on the same SCSI bus as the CD-ROM drive and you do not have a model 1RY or 2RY, you must terminate the internal SCSI bus by attaching an active terminator, IBM Part Number 94G7587, to the last connector on the internal SCSI cable. (Models 1RY and 2RY come with a self-terminating cable.)

- If you want the ServeRAID II or ServeRAID-3H adapter to control the CD-ROM drive:

  1. Leave the CD-ROM drive attached to the internal SCSI cable.
  2. Disconnect the internal SCSI cable from the system board.
  3. Attach the internal SCSI cable to an internal channel on the ServeRAID adapter.
  4. If you are not using a model 1RY or 2RY, attach a terminated hard disk drive to the last connector on the internal cable.

- When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the PC Server 325, the PCI slots are scanned in the following order: 3, 2, 1, 6, 5, 4.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters and controllers, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. In a clustered environment, both ServeRAID adapters in a pair must be of the same type and must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

- You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

PC Server 330 Standard Features

The following table provides basic information about the PC Server 330 models. IBM also tested earlier models of the PC Server 330 in clustered environments. You can obtain information about earlier models and the optional devices supported on those models at the following World Wide Web address: `http://www.pc.ibm.com/us/netfinity/`

PC Server 330	8640-PM0	8640-PT0	8640-PB0	8640-11Y	8640-21Y
Form Factor	All five models are floor-standing towers.				
Microprocessor	200 MHz[68]	233 MHz[69]	266 MHz[69]	300 MHz[69]	333 MHz[69]
Level-2 Cache	All five models have 512 KB of level-2 cache.				
SMP[70]	All five models support 2-way SMP.				
Memory EDO ECC (standard/maximum)	64 MB/1 GB	64/512 MB	64/512 MB	64/512 MB	64 MB/1 GB
Bus Architecture	All five models support PCI/ISA bus architectures.				
PCI Disk Controller[71]	All five models have an integrated Wide Ultra SCSI controller.				
RAID Controller[72]	All five models have an integrated single-channel Wide Ultra SCSI ServeRAID controller.				
I/O Slots[73]	All five models have 4 PCI and 2 PCI/ISA slots.				
Diskette Drive	All five models have a 3.5 in., 1.44 MB diskette drive in Bay 8.				
CD-ROM Drive	All five models have an 8X SCSI CD-ROM drive in Bay 7.				
Hard Disk Drives (standard)	All five models have 0 preinstalled hard disk drives.				
Hot-Swap Bays	All five models have six hot-swap hard disk drive bays.				
3.5-inch Device Bays	All five models have one empty 3.5-inch drive bay.				
5.25-inch Device Bays	All five models have one empty 5.25-inch drive bay.				
Power Supply	All five models have one 350 Watt power supply.				
I/O Ports	All five models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, and 1 RJ-45 10/100 Ethernet ports.				

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[68] Intel Pentium Pro microprocessor.

[69] Intel Pentium II microprocessor.

[70] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[71] This integrated Ultra SCSI controller has two 68-pin connectors (one internal and one external), and it supports up to fifteen Wide Ultra SCSI devices.

[72] This single-channel ServeRAID II controller has a 68-pin (wide) connector on the system board and supports RAID levels 0, 1, Enhanced 1, and 5.

[73] Model 21Y comes with an IBM Systems Management Adapter preinstalled in PCI slot 4.

Optional Devices Supported on the PC Server 330

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Hard Disk Drive	94G7491	IBM 4.51 GB Wide Ultra SCSI Hot-Swap (slim line)
Hard Disk Drive	94G7492[74]	IBM 9.1 GB Wide Ultra SCSI Hot-Swap (half high)
Hard Disk Drive	02K0477	IBM 9.1 GB Wide Ultra SCSI Hot-Swap (slim line)
Hard Disk Drive	02K0478[74]	IBM 18.2 GB Wide Ultra SCSI Hot-Swap (half high)
Hard Disk Drive	01K1327	IBM 4.5 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	01K1328	IBM 9.1 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	76H2687	IBM Ultrastar 2XP 4.51 GB Wide Ultra SCSI (slim line)
Hard Disk Drive	76H2689	IBM Ultrastar 2XP 9.1 GB Wide Ultra SCSI (half high)
Memory	94G6473	32 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G6474	64 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G6475	128 MB, 60 ns, EDO ECC DIMM (3.3V)
Memory	94G7079	256 MB, 60 ns, EDO ECC DIMM (3.3V)
Microprocessor Board	94G7081	Processor board needed to upgrade from Pentium Pro to Pentium II
Microprocessor Upgrade	94G6463	200 MHz Pentium Pro with 512KB Level-2 cache
Microprocessor Upgrade	01K6599	233 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	01K6600	266 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	10L5886	300 MHz Pentium II with 512KB Level-2 cache
Microprocessor Upgrade	01K8025	333 MHz Pentium II with 512KB Level-2 cache
Monitor	654000x[75]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[75]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654600x[75]	G52 15-inch Color Monitor, white (13.6-inch image size)
Monitor	65460Ax[75]	G54 15-inch Color Monitor, white (13.7-inch image size)
Monitor	654700x[75]	G72 17-inch Color Monitor, white (15.7-inch image size)
Monitor	65470Ax[75]	G74 17-inch Color Monitor, white (15.9-inch image size)
Network Adapter	86H2432	IBM 100/10 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[76]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
SCSI Cable	70G9857	Fast/Wide to Fast/Wide External SCSI Cable

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[74] This drive occupies two hot-swap bays; therefore, you can install a maximum of three.

[75] The "x" varies by geographic location.

[76] The ServeRAID adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[77] Requires 68-pin to 50-pin converter, IBM Part Number 32G3925.

[78] Comes with a 68-pin to 50-pin converter and required bezels.

[79] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
SCSI Cable	70G9858	Fast/Wide to Fast External SCSI Cable
Security	94G7527	Security Cover Kit and Cable Option
Systems Management	94G7578	Advanced Systems Management Adapter
Tape Drive	76H0485	20/40 GB 8-mm SCSI Tape Drive
Tape Drive	06H9716[77]	TR4 4/8 GB Internal Tape Drive
Tape Drive	01K1319[78]	10/20 GB NS Internal Tape Drive
Tape Drive	01K1282[78]	12/24 GB DDS/3 4mm Internal Tape Drive
UPS	94G3134[79]	APC Smart-UPS 700 (20 minute runtime at 300 Volt Amps)
UPS	94G3135[79]	APC Smart-UPS 1000 (36 minute runtime at 300 Volt Amps)
UPS	94G3136[79]	APC Smart-UPS 1400 (57 minute runtime at 300 Volt Amps)
Video Memory	76H0238	Video Memory Upgrade (1 MB)

Configuration Tips for the PC Server 330

- All five models come with an integrated single-channel Ultra SCSI ServeRAID II controller on the system board. You can use this controller to configure redundant (level-1 or level-5) arrays for the internal, nonshared, startup (boot) drives.

- If you connect the startup drives to the ServeRAID controller on the system board, you must install the RAID adapters that control the shared-drive resources only in PCI slots 4, 5, and 6.

- You *must* use IBM 100/10 PCI EtherJet Adapters for the cluster's heartbeat connection.

- You can use the integrated Ethernet controllers that come standard on some server models to connect the server to the public network; however, these integrated controllers *are not* certified for use as the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters and controllers, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. In a clustered environment, both ServeRAID adapters in a pair must be of the same type and must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Netfinity 5000 Standard Features

The following table provides basic information about the recently announced Netfinity 5000.

Netfinity 5000	8659-12Y	8659-1SY	8659-22Y	8659-2SY	8659-31Y	8659-3RY
Form Factor	Tower	Rack[80] (5U)[81]	Tower	Rack[80] (5U)[81]	Tower	Rack[80] (5U)[81]
Microprocessor	350 MHz[82]	350 MHz[82]	400 MHz[82]	400 MHz[82]	450 MHz[82]	450 MHz[82]
Level-2 Cache	All six models have 512 KB of level-2 cache.					
SMP	All six models support 2-way SMP[83]					
Memory ECC	All six models come with 64 MB of ECC memory and support a maximum of 1 GB of ECC memory.					
Bus Architecture	All six models support both PCI and ISA bus architectures.					
Integrated Disk Controller	All six models have an integrated, dual channel, Wide Ultra SCSI controller.					
I/O Slots	All six models have three 32-bit PCI slots and two combination 32-bit PCI/16-bit ISA expansion slots.					
Diskette Drive	All five models have a 3.5 in., 1.44 MB diskette drive.					
CD-ROM Drive	All six models have a 32X[84] IDE CD-ROM drive.					
Hard Disk Drives (standard)	All six models have 0 preinstalled hard disk drives.					
Hot-Swap Bays	All six models have five hot-swap hard disk drive bays.					
5.25-inch Device Bays	All six models have two (one empty) 5.25-inch removable-media drive bays.					
Power Supply	All six models come with one 350 Watt (non-redundant) supply, but they support an additional 175 Watt redundant power supply. You can install the optional 175 Watt power supply for 350 Watt redundancy.					
I/O Ports	All six models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, one dual-channel Wide Ultra SCSI controller, and 1 Ethernet 10/100 ports.					

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[80] For use with the IBM Netfinity Rack (9306900) or an industry-standard, 19-inch rack that meets EIA-310-D standards with a minimum depth of 28 inches.

[81] 1U is 44.45 mm (1.75 inches).

[82] Intel Pentium II microprocessor.

[83] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[84] The actual playback speed for this variable-speed drive varies and is often less than the maximum possible.

Optional Devices Supported on the Netfinity 5000

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Conversion Kit	10L7006	Netfinity 5000 Tower to Rack Conversion Kit
Conversion Kit	10L6972	Netfinity 5000 Rack to Tower Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Hard Disk Drive	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap (slim line)
Hard Disk Drive	01K8053	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8055[85]	Netfinity 18.2 GB Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8009	Netfinity 4.51 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8054	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8503[85]	Netfinity 18.2 GB 10K Wide Ultra SCSI SCA-2
Memory Kit	01K7241	Netfinity 64MB SDRAM ECC RDIMM
Memory Kit	01K7262	IBM 128MB SDRAM ECC RDIMM
Memory Kit	01K8043	Netfinity 256MB SDRAM ECC RDIMM
Microprocessor Upgrade	10L5883	350 MHz with 512 KB Level-2 cache
Microprocessor Upgrade	10L5884	400 MHz with 512 KB Level-2 cache
Microprocessor Upgrade	10L5900	450 MHz with 512 KB Level-2 cache
Monitor	654000x[86]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[86]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[86]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65464Ax[86]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)
Monitor	654740x[86]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65474Ax[86]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	08L3341	IBM Netfinity 10/100 Fault Tolerant Adapter
Network Adapter	08L2549	IBM 10/100 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
Power Supply	10L7007	Netfinity 175 Watt Redundant Power Option
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[87]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
SCSI Adapter	02K3454	IBM PCI Fast/Wide Ultra SCSI Adapter
Tape Drive	01K1282	IBM 12/24 GB DDS/3 4mm Internal Drive
Tape Drive	01K1319	IBM 10/20 GB NS Internal SCSI Tape Drive
Tape Drive	01K1325	IBM 20/40 GB 8mm SCSI Tape Drive
UPS	94G6674[88]	APC Smart-UPS 1400 RMB (23 minute runtime at 330 Volt Amps)

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[85] This drive occupies two bays.

[86] The "x" varies by geographic location.

[87] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[88] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
UPS	94G6676[88]	APC Smart-UPS 3000 RMB (62 minute runtime at 330 Volt Amps)
UPS	94G3136[88]	APC Smart-UPS 1400 (30 minute runtime at 330 Volt Amps)
UPS	94G3135[88]	APC Smart-UPS 1000 (19 minute runtime at 330 Volt Amps)

Configuration Tips for the Netfinity 5000

- When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. The Netfinity 5000 has two primary PCI buses: PCI bus 1 and PCI bus 2. Expansion slot 5 is on PCI bus 1 and expansion slots 1 through 4 are on PCI bus 2. The system scans PCI bus 1 (slot 5) first.

- The Netfinity 5000 comes with five hot-swap drive bays, but no RAID controller. You can create a RAID subsystem in a Netfinity 5000 by installing a single-channel ServeRAID-3L adapter in the server and moving the SCSI cable from the system board SCSI connector to the internal connector on the ServeRAID-3L adapter.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Netfinity 5500 Standard Features, Tower Models

The following table provides basic information about tower models of the Netfinity 5500. See "Netfinity 5500 Standard Features, Rack Models" on page 56 for information about the Netfinity 5500 rack-ready models and see "Netfinity 5500 M10 Standard Features" on page 60 for information about the recently announced tower and rack-ready models of the Netfinity 5500 M10.

Netfinity 5500	8660-11U	8660-41U	8660-42U	8660-51U	8660-52U
Form Factor	All five of these models are floor-standing towers.				
Microprocessor	350 MHz[89]	400 MHz[89]	400 MHz[89]	450 MHz[89]	450 MHz[89]
Level-2 Cache	All five models have 512 KB of level-2 cache.				
SMP	All five models support 2-way SMP[90]				
Memory ECC (standard/maximum[91])	128 MB/1 GB	128 MB/1 GB	256 MB/1 GB	128 MB/1 GB	256 MB/1 GB
Bus Architecture	All five models support PCI/ISA bus architectures.				
RAID Controller[92]	All five models have an integrated dual-channel Wide Ultra SCSI ServeRAID controller.				
I/O Slots	All five models have six PCI and one PCI/ISA slot.				
Diskette Drive	All five models have a 3.5 in., 1.44 MB diskette drive.				
CD-ROM Drive	All five models have a 32X-14X[93] IDE CD-ROM drive.				
Hard Disk Drives (standard)	All five models have 0 preinstalled hard disk drives.				
Hot-Swap Bays	All five models have six hot-swap hard disk drive bays.				
5.25-inch Device Bays	All five models have three (two empty) 5.25-inch removable-media drive bays.				
NetBAY3	All five tower models come with a NetBAY3, 3U stackable expansion enclosure.				
Power Supply	All five models have one 400 Watt power supply.				
I/O Ports	All five models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, 2 ServeRAID channels, and 1 Ethernet 10/100 ports.				

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[89] Intel Pentium II microprocessor.

[90] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[91] Netfinity 5500 models that have the Pentium II Xeon microprocessor upgrades installed support a maximum memory capacity of 2 GB.

[92] This dual channel ServeRAID controller has 68-pin (wide) connectors on the system board and supports RAID levels 0, 1, Enhanced 1, and 5.

[93] The actual playback speed for this variable-speed drive varies and is often less than the maximum possible.

Netfinity 5500 Standard Features, Rack Models

The following table provides basic information about rack-ready models of the Netfinity 5500. See "Netfinity 5500 Standard Features, Tower Models" on page 55 for information about the Netfinity 5500 tower models and see "Netfinity 5500 M10 Standard Features" on page 60 for information about the recently announced tower and rack-ready models of the Netfinity 5500 M10.

Netfinity 5500	8660-1RU	8660-4RU	8660-4SU	8660-5RU	8660-5SU
Form Factor	All five models are 8U[94] and rack ready[95]				
Microprocessor	350 MHz[96]	400 MHz[96]	400 MHz[96]	450 MHz[96]	450 MHz[96]
Level-2 Cache	All five models have 512 KB of level-2 cache.				
SMP	All five models support 2-way SMP[97]				
Memory ECC (standard/maximum[98])	128 MB/1 GB	128 MB/1 GB	256 MB/1 GB	128 MB/1 GB	256 MB/1 GB
Bus Architecture	All five models support PCI/ISA bus architectures.				
RAID Controller[99]	All five models have an integrated dual-channel Wide Ultra SCSI ServeRAID controller.				
I/O Slots	All five models have six PCI and one PCI/ISA slot.				
Diskette Drive	All five models have a 3.5 in., 1.44 MB diskette drive.				
CD-ROM Drive	All five models have a 32X-14X[100] IDE CD-ROM drive.				
Hard Disk Drives (standard)	All five models have 0 preinstalled hard disk drives.				
Hot-Swap Bays	All five models have six hot-swap hard disk drive bays.				
5.25-inch Device Bays	All five models have three (two empty) 5.25-inch removable-media drive bays.				
Power Supply	All five models come with one 400 Watt power supply.				
I/O Ports	All five models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, 2 ServeRAID channels, and 1 Ethernet 10/100 ports.				

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[94] 1U is 44.45 mm (1.75 inches).

[95] For use with the IBM Netfinity Rack (9306900), Netfinity NetBAY22 (9306200), or an industry-standard, 19-inch rack that meets EIA-310-D standards with a minimum depth of 28 inches.

[96] Intel Pentium II microprocessor.

[97] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[98] Netfinity 5500 models that have the Pentium II Xeon microprocessor upgrades installed support a maximum memory capacity of 2 GB.

[99] This dual channel ServeRAID controller has 68-pin (wide) connectors on the system board and supports RAID levels 0, 1, Enhanced 1, and 5.

[100] The actual playback speed for this variable-speed drive varies and is often less than the maximum possible.

Optional Devices Supported on the Netfinity 5500

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Cable	03K9313	IBM Netfinity SCSI Controller Cable (0.8-mm)
Casters	10L6913	IBM Netfinity Caster Set
Conversion Kit	01K8020	Netfinity 5500 Tower to Rack Conversion Kit
Conversion Kit	01K8021	Netfinity 5500 Rack to Tower Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Converter	32G3925	SCSI 68-pin to 50-pin Converter.
Fibre Channel Adapter	01K7297	IBM Netfinity Fibre Channel PCI Adapter
Hard Disk Drive	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap (slim line)
Hard Disk Drive	01K8053	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8055[101]	Netfinity 18.2 GB Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8009	Netfinity 4.51 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8054	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8503[101]	Netfinity 18.2 GB 10K Wide Ultra SCSI SCA-2 (for NetBAY3)
Hard Disk Storage	10L6912	IBM Netfinity NetBAY3[102]
Memory Kit	01K8022	Netfinity 64MB SDRAM ECC DIMM (for models x1U and xRU)
Memory Kit	01K8023	IBM 128MB SDRAM ECC DIMM (for models x1U and xRU)
Memory Kit	01K7262[104]	Netfinity 128MB SDRAM ECC RDIMM
Memory Kit	01K8043[104]	Netfinity 256MB SDRAM ECC RDIMM[103]
Memory Kit	01K7263[104]	Netfinity 512MB SDRAM ECC RDIMM
Microprocessor Upgrade	10L5883	350 MHz with 512 KB Level-2 cache (1xU models)
Microprocessor Upgrade	10L5884	400 MHz with 512 KB Level-2 cache (4xU models)
Microprocessor Upgrade	10L5900	450 MHz with 512 KB Level-2 cache (5xU models)
Microprocessor Upgrade	01K7264[104]	400 MHz with 512 KB Level-2 cache
Microprocessor Upgrade	10L5894[104]	400 MHz with 1 MB Level-2 cache
Microprocessor Board Upgrade	01K8049	Netfinity Processor Upgrade for Pentium II Xeon Microprocessors
Monitor	654000x[105]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[105]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[105]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65464Ax[105]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)

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[101] This drive occupies two bays.

[102] One 3U NetBAY3 stackable expansion option comes with Netfinity 5500 tower models, but a total of three are supported.

[103] In models x1U and xRU, you must remove any previously installed 01K8022 or 01K8023 DIMMs before you can install this RDIMM.

[104] Requires the Netfinity Pentium II Xeon Microprocessor Upgrade, part number 01K8049.

[105] The "x" varies by geographic location.

[106] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[107] You must install an IBM Netfinity Fibre Channel PCI Adapter (01K7297) in the server to attach this external fibre-channel RAID controller.

[108] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
Monitor	654740x[105]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65474Ax[105]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	08L3341	IBM Netfinity 10/100 Fault Tolerant Adapter
Network Adapter	86H2432	IBM 100/10 PCI EtherJet Adapter
Network Adapter	08L2549	IBM 10/100 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
Power Supply	01K8026	Netfinity 400 Watt Hot-Swap Redundant Power Option
Power Supply	01K7951	Netfinity 400 Watt Hot-Swap Redundant Power Supply II
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[106]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
RAID Controller	35261RU[107]	IBM Netfinity Fibre Channel RAID Controller Unit
SCSI Adapter	02K3454	IBM PCI Fast/Wide Ultra SCSI Adapter
SCSI Adapter	76H3579	IBM PCI Fast/Wide Ultra SCSI Adapter
Tape Drive	01K1282	IBM 12/24 GB DDS/3 4mm Internal Drive
Tape Drive	01K1325	IBM 20/40 GB 8mm SCSI Tape Drive
Tape Drive	01K1320	IBM 20/40 GB DLT SCSI Tape Drive
Tape Drive	04K0149	IBM 35/70 GB Internal DLT Drive
Tape Drive	01K1174	IBM 35/70 GB External DLT Drive
UPS	94G6674[108]	APC Smart-UPS 1400 RMB (21 minute runtime at 375 Volt Amps)
UPS	94G6676[108]	APC Smart-UPS 3000 RMB (55 minute runtime at 375 Volt Amps)
UPS	94G3136[108]	APC Smart-UPS 1400 (28 minute runtime at 375 Volt Amps)

Configuration Tips for the Netfinity 5500

- All models come with an integrated dual-channel ServeRAID controller on the system board. You can use this controller to configure redundant (level-1, enhanced level-1, or level-5) arrays for the internal, nonshared, startup (boot) drives.

- In the Netfinity 5500, expansion slots 5 and 6 are on the primary PCI bus and expansion slots 1 through 4 are on the secondary PCI bus. The system scans these slots to assign system resources; then, the system starts (boots) the PCI devices in the following order: system board devices, slot 5, slot 6, slot 1, slot 2, slot 3, and finally slot 4.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Netfinity 5500 M10 Standard Features

The following table provides basic information about the recently announced rack and tower models of the Netfinity 5500 M10. See "Netfinity 5500 Standard Features, Tower Models" on page 55 and "Netfinity 5500 Standard Features, Rack Models" on page 56 for information about earlier models of the Netfinity 5500.

Netfinity 5500 M10	8661-1RY	8661-11Y	8661-2RY
Form Factor	Rack[109] (8U)[110]	Tower	Rack[109] (8U)[110]
Microprocessor	400 MHz[111]	400 MHz[111]	400 MHz[111]
Level-2 ECC Cache	512 KB	512 KB	1024 KB
SMP	All three models support 2-way SMP[112]		
Memory ECC 100 MHz (standard/maximum)	128 MB/2 GB	128 MB/2 GB	128 MB/2 GB
Bus Architecture	All three models support PCI/ISA bus architectures.		
RAID Controller	All three models have an integrated dual-channel Wide Ultra SCSI ServeRAID[113] controller.		
I/O Slots	All three models have six PCI and one PCI/ISA slot.		
Diskette Drive	All three models have a 3.5 in., 1.44 MB diskette drive.		
CD-ROM Drive	All three models have a 32X-14X[114] IDE CD-ROM drive.		
Hard Disk Drives (standard)	All three models have 0 preinstalled hard disk drives.		
Hot-Swap Bays	All three models have six hot-swap hard disk drive bays.		
5.25-inch Device Bays	All three models have three (two empty) 5.25-inch removable-media drive bays.		
NetBAY3	The tower model (8661-11Y) comes with a NetBAY3, 3U stackable expansion enclosure.		
Power Supply	All three models come with one 400 Watt power supply, but you can install an additional 400 Watt hot-swap supply for redundancy.		
I/O Ports	All three models have 2 serial, 2 USB, 1 parallel, 1 video, 1 mouse, 1 keyboard, 2 ServeRAID channels, and 1 Ethernet 10/100 ports.		

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[109] For use with the IBM Netfinity Rack (9306900), Netfinity NetBAY22 (9306200), or an industry-standard, 19-inch rack that meets EIA-310-D standards with a minimum depth of 28 inches.

[110] 1U is 44.45 mm (1.75 inches).

[111] Intel Pentium II Xeon microprocessor.

[112] Both microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[113] This dual channel ServeRAID controller has 68-pin (wide) connectors on the system board and supports RAID levels 0, 1, Enhanced 1, and 5.

[114] The actual playback speed for this variable-speed drive varies and is often less than the maximum possible.

Optional Devices Supported on the Netfinity 5500 M10

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Cable	03K9313	IBM Netfinity SCSI Controller Cable (0.8-mm)
Casters	10L6913	IBM Netfinity Caster Set
Conversion Kit	01K8020	Netfinity 5500 Tower to Rack Conversion Kit
Conversion Kit	01K8021	Netfinity 5500 Rack to Tower Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Converter	32G3925	SCSI 68-pin to 50-pin Converter.
Fibre Channel Adapter	01K7297	IBM Netfinity Fibre Channel PCI Adapter
Hard Disk Drive	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap (slim line)
Hard Disk Drive	01K8053	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8055[115]	Netfinity 18.2 GB Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8009	Netfinity 4.51 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8054	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8503[115]	Netfinity 18.2 GB 10K Wide Ultra SCSI SCA-2 (for NetBAY3)
Hard Disk Storage	10L6912	IBM Netfinity NetBAY3[116]
Memory Kit	01K7262	Netfinity 128MB SDRAM ECC RDIMM
Memory Kit	01K8043	Netfinity 256MB SDRAM ECC RDIMM
Memory Kit	01K7263	Netfinity 512MB SDRAM ECC RDIMM
Microprocessor Upgrade	01K7264	400 MHz with 512 KB Level-2 cache
Microprocessor Upgrade	10L5894	400 MHz with 1 MB Level-2 cache
Monitor	654000x[117]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[117]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[117]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65464Ax[117]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)
Monitor	654740x[117]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65474Ax[117]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	08L3341	IBM Netfinity 10/100 Fault Tolerant Adapter
Network Adapter	86H2432	IBM 100/10 PCI EtherJet Adapter
Network Adapter	08L2549	IBM 10/100 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
Power Supply	01K8026	Netfinity 400 Watt Hot-Swap Redundant Power Option
Power Supply	01K7951	Netfinity 400 Watt Hot-Swap Redundant Power Supply II

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[115] This drive occupies two bays.

[116] One NetBAY3 option comes with Netfinity 5500 tower models, but a total of three are supported.

[117] The "x" varies by geographic location.

[118] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[119] You must install an IBM Netfinity Fibre Channel PCI Adapter (01K7297) in the server to attach this external fibre-channel RAID controller.

[120] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[118]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
RAID Controller	35261RU[119]	IBM Netfinity Fibre Channel RAID Controller Unit
SCSI Adapter	02K3454	IBM PCI Fast/Wide Ultra SCSI Adapter
Tape Drive	01K1282	IBM 12/24 GB DDS/3 4mm Internal Drive
Tape Drive	01K1325	IBM 20/40 GB 8mm SCSI Tape Drive
Tape Drive	01K1320	IBM 20/40 GB DLT SCSI Tape Drive
Tape Drive	04K0149	IBM 35/70 GB Internal DLT Drive
Tape Drive	01K1174	IBM 35/70 GB External DLT Drive
UPS	94G6674[120]	APC Smart-UPS 1400 RMB (21 minute runtime at 375 Volt Amps)
UPS	94G6676[120]	APC Smart-UPS 3000 RMB (55 minute runtime at 375 Volt Amps)
UPS	94G3136[120]	APC Smart-UPS 1400 (28 minute runtime at 375 Volt Amps)

Configuration Tips for the Netfinity 5500 M10

- All models come with an integrated dual-channel ServeRAID controller on the system board. You can use this controller to configure redundant (level-1, enhanced level-1, or level-5) arrays for the internal, nonshared, startup (boot) drives.

- In the Netfinity 5500, expansion slots 5 and 6 are on the primary PCI bus and expansion slots 1 through 4 are on the secondary PCI bus. The system scans these slots to assign system resources; then, the system starts (boots) the PCI devices in the following order: system board devices, slot 5, slot 6, slot 1, slot 2, slot 3, and finally slot 4.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Netfinity 7000 Standard Features

The following table provides basic information about Netfinity 7000 models. For information about the recently announced Netfinity 7000 M10 models, see "Netfinity 7000 M10 Standard Features" on page 67.

Netfinity 7000	8651-RM0	8651-RH0	8651-TM0	8651-TH0
Form Factor	Rack[121] (11U)[122]	Rack[121] (11U)[122]	Tower	Tower
Microprocessor	200 MHz[123]	200 MHz[123]	200 MHz[123]	200 MHz[123]
Level-2 Cache	512 KB	1 MB	512 KB	1 MB
SMP[124]	4-way	4-way	4-way	4-way
Memory ECC (standard/maximum)	256 MB/4 GB	256 MB/4 GB	256 MB/4 GB	256 MB/4 GB
Bus Architecture	PCI/EISA	PCI/EISA	PCI/EISA	PCI/EISA
Two Disk Controllers[125] (PCI, integrated)	Wide Ultra SCSI	Wide Ultra SCSI	Wide Ultra SCSI	Wide Ultra SCSI
I/O Slots	6 PCI, 4 EISA	6 PCI, 4 EISA	6 PCI, 4 EISA	6 PCI, 4 EISA
Diskette Drive	3.5 in., 1.44 MB	3.5 in., 1.44 MB	3.5 in., 1.44 MB	3.5 in., 1.44 MB
CD-ROM Drive	8X IDE	8X IDE	8X IDE	8X IDE
Hard Disk Drives (standard)	0	0	0	0
Hot-Swap[126] **Bays**	12	12	12	12
Device Bays[127]	4	4	4	4
Hot-Swap[126] **400W Power Supplies** (standard/maximum)	2/3	2/3	2/3	2/3
Hot-Swap[126] **Fans**	3	3	3	3
I/O Ports	2 serial, 1 parallel, 1 video, 1 mouse, 1 keyboard.			

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[121] For use with the IBM Netfinity Rack (9306900) or an industry-standard, 19-inch rack that meets EIA-310-D standards with a minimum depth of 30 inches.

[122] 1U is 44.45 mm (1.75 inches).

[123] Intel Pentium Pro microprocessor.

[124] All microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[125] These Ultra SCSI controllers each support up to fifteen, 68-pin SCSI devices.

[126] The hot-swap features enable you to remove and replace hard disk drives, fans, and power supplies without turning off the server.

[127] Each device bay can accommodate one half-high device. Two device bays can be used to accommodate one full-high device.

Optional Devices Supported on the Netfinity 7000

Option	Part Number	Description
Backplane Repeater	94G7426[128]	Netfinity 7000 Backplane Repeater Kit
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Bulkhead Cable	94G7421[129]	Netfinity PCI SCSI Controller to Bulkhead Cable
Conversion Kit	94G7424	Netfinity 7000 Tower to Rack Conversion Kit
Conversion Kit	94G7425	Netfinity 7000 Rack to Tower Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Hard Disk Drive	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap (slim line)
Hard Disk Drive	94G7430[130]	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 Hot-Swap (half high)
Hard Disk Drive	01K8053	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8055[130]	Netfinity 18.2 GB Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8009	Netfinity 4.51 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8054	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8010[130]	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8503[130]	Netfinity 18.2 GB 10K Wide Ultra SCSI SCA-2 (half high)
Memory Kit	94G7384	Netfinity 256 MB DIMM Kit (4 x 64 MB DIMMs)
Memory Kit	94G7385	Netfinity 512 MB DIMM Kit (4 x 128 MB DIMMs)
Memory Kit	94G7386	Netfinity 1024 MB DIMM Kit (4 x 256 MB DIMMs)
Microprocessor Upgrade	94G6678	200 MHz with 512 KB Level-2 cache
Microprocessor Upgrade	94G7147	200 MHz with 1 MB Level-2 cache
Microprocessor Board Upgrade	94G7387	Netfinity Processor Board for 200 MHz/1 MB microprocessors
Monitor	654000x[131]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[131]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[131]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65464Ax[131]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)
Monitor	654740x[131]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65474Ax[131]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	86H2432	IBM 100/10 PCI EtherJet Adapter
Network Adapter	08L2549	IBM 10/100 PCI EtherJet Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
Power Supply	94G7150 or 01K8026	Netfinity 400 Watt Hot-Swap Redundant Power Option

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[128] This kit connects the hot-swap backplanes together to support up to 12 internal drives on one SCSI or ServeRAID channel.

[129] This cable enables you to use a SCSI controller on the system board to support external SCSI devices.

[130] This drive occupies two bays.

[131] The "x" varies by geographic location.

[132] The ServeRAID II adapter firmware, BIOS code, device drivers, and utility programs must be at version 2.40 or higher.

[133] Requires bulkhead cable, IBM Part Number 94G7421.

[134] If installed as the last or only device on the SCSI bus, the IBM Part Number 94G7587 terminator is required.

[135] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
Power Supply	01K7951	Netfinity 400 Watt Hot-Swap Redundant Power Supply II
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	76H3584[132]	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
Security	94G7427	Netfinity Security Cover III
Tape Drive	01K1282	IBM 12/24 GB DDS/3 4mm Internal Drive
Tape Drive	01K1325	IBM 20/40 GB 8mm SCSI Tape Drive
Tape Drive	01K1320	IBM 20/40 GB DLT SCSI Tape Drive
Tape Drive	04K0149	IBM 35/70 GB Internal DLT Drive
Tape Drive	01K1174[133]	IBM 35/70 GB External DLT Drive
Tape Drive	76H0485[134]	20/40 GB 8-mm SCSI Tape Drive
Terminator	94G7587	Active terminator for internal SCSI cable.
UPS	94G6674[135]	APC Smart-UPS 1400 RMB (19 minute runtime at 490 Volt Amps)
UPS	94G6676[135]	APC Smart-UPS 3000 RMB (60 minute runtime at 490 Volt Amps)
UPS	94G3136[135]	APC Smart-UPS 1400 (22 minute runtime at 490 Volt Amps)

Configuration Tips for the Netfinity 7000

- The Netfinity 7000 contains two backplanes, and each backplane is connected to a Wide Ultra SCSI controller on the system board. If you want to configure an array using drives in the hot-swap bays, you can move the SCSI cable connector from a controller on the system board to an internal channel connector on the ServeRAID adapter.

- If you want to control all 12 of the hot-swap bays using one channel of the ServeRAID adapter or using one of the Ultra SCSI controllers on the system board, you will need an IBM Netfinity Backplane Repeater Kit, Part Number 94G7426, to connect the two backplanes.

- When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the Netfinity 7000, the PCI slots are scanned in the following order: 1, 2, 3, 4, 5, 6.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 100/10 PCI EtherJet Adapters or IBM 10/100 EtherJet PCI Adapters for the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Netfinity 7000 M10 Standard Features

The following table provides basic information about the recently announced Netfinity 7000 M10 models.

Netfinity 7000 M10	8680-1RU	8680-2RU
Form Factor	Rack[136] (11U)[137]	Rack[136] (11U)[137]
Microprocessor	400 MHz[138]	400 MHz[138]
Level-2 Cache	512 KB	1 MB
SMP	4-way[139]	4-way[139]
Memory EDO ECC (standard/maximum)	128 MB/8 GB	256 MB/8 GB
Bus Architecture	PCI	PCI
Integrated Disk Controller	Dual Channel, PCI Wide Ultra SCSI	Dual Channel, PCI Wide Ultra SCSI
32-Bit Hot-Swap[140] PCI Slots	7	7
64-Bit Hot-Swap[140] PCI Slots	5	5
Diskette Drive	3.5 in., 1.44 MB	3.5 in., 1.44 MB
CD-ROM Drive	32X-14X IDE[141]	32X-14X IDE[141]
Hard Disk Drives (standard)	0	0
Hot-Swap[140] Bays	4	4
Device Bays[142] (standard/available)	6/4[143]	6/4[143]
Hot-Swap[140] 400 Watt Power Supplies (standard/maximum)	1/3	2/3
Hot-Swap[140] Fans	4	4
I/O Ports	2 serial, 2 universal serial bus (USB), 1 parallel, 1 video, 1 mouse, 1 keyboard.	

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[136] Requires an IBM Netfinity Rack (9306900), Netfinity NetBay22 (9306200), or an industry-standard, 19-inch rack with a minimum depth of 29.23 inches.

[137] 1U is 44.45 mm (1.75 inches).

[138] Intel Pentium II Xeon microprocessor.

[139] All microprocessors installed in the system must be identical. Mixing microprocessors with different frequencies or cache sizes within the same system is not supported.

[140] The hot-swap features enable you to remove and replace hard disk drives, fans, PCI adapters, and power supplies without turning off the server.

[141] The actual playback speed for this variable-speed drive varies and is often less than the maximum possible.

[142] Each device bay can accommodate one half-high device. Two device bays can be used to accommodate one full-high device.

[143] One device bay contains an IDE CD-ROM drive and one device bay contains a 3.5-inch diskette drive.

Optional Devices Supported on the Netfinity 7000 M10

Option	Part Number	Description
Battery Backup	76H5401	ServeRAID II 8MB/Battery-Backup Cache
Battery Backup	28L1003	ServeRAID-3H 32MB/Battery-Backup Cache
Conversion Kit	01K8005	Netfinity 7000 M10 Rack to Tower Conversion Kit
Converter	01K8017	8-mm to 68-pin Converter (required for the quorum-arbitration link when using Microsoft Cluster Server with a ServeRAID II or ServeRAID-3H adapter)
Fibre Channel Adapter	01K7297	IBM Netfinity Fibre Channel PCI Adapter
Hard Disk Drive	94G7429	Netfinity 4.51 GB Wide Ultra SCSI SCA-2 Hot-Swap (slim line)
Hard Disk Drive	01K8053	Netfinity 9.1 GB Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8055[144]	Netfinity 18.2 GB Wide Ultra SCSI SCA-2 (half high)
Hard Disk Drive	01K8009	Netfinity 4.51 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8054	Netfinity 9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk Drive	01K8503[144]	Netfinity 18.2 GB 10K Wide Ultra SCSI SCA-2 (half high)
Memory Card	01K8004[145]	Netfinity 7000 M10 Memory Expansion Card
Memory Kit	01K8044[146]	Netfinity 7000 M10 256 MB DIMM Kit (4 x 64 MB DIMMs)
Memory Kit	01K8045	Netfinity 7000 M10 512 MB DIMM Kit (4 x 128 MB DIMMs)
Memory Kit	01K8046	Netfinity 7000 M10 1 GB DIMM Kit (4 x 256 MB DIMMs)
Microprocessor Upgrade	01K8006	400 MHz with 512 KB Level-2 cache (for model 1RU)
Microprocessor Upgrade	01K8007	400 MHz with 1 MB Level-2 cache (for model 2RU)
Monitor	654000x[147]	G42 14-inch Color Monitor, white (13.2-inch image size)
Monitor	654102x[147]	G51 15-inch Color Monitor, white (13.6-inch image size)
Monitor	654640x[147]	G52 15-inch Color Monitor, stealth gray (13.6-inch image size)
Monitor	65464Ax[147]	G54 15-inch Color Monitor, stealth gray (13.7-inch image size)
Monitor	654740x[147]	G72 17-inch Color Monitor, stealth gray (15.7-inch image size)
Monitor	65474Ax[147]	G74 17-inch Color Monitor, stealth gray (15.9-inch image size)
Network Adapter	08L2549	IBM 10/100 PCI EtherJet Adapter
Network Adapter	08L3341	IBM Netfinity 10/100 Fault Tolerant Adapter
Network Adapter	41H8900	IBM PCI Token-Ring Adapter
Power Cord	01K7952	Netfinity 700 M10 Dual Cord Power Unit
Power Supply	01K7951	Netfinity 400 Watt Hot-Swap Redundant Power Supply II
RAID Cable	76H5400	Cable to use the ServeRAID II adapter's third channel externally
RAID Controller	01K7207	IBM Netfinity ServeRAID-3H Ultra2 SCSI Adapter (3 channels)

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[144] This drive occupies two bays.

[145] Required to install DIMMs in Banks 5 through 8.

[146] DIMM sizes can vary from Bank to Bank, but DIMM sizes must be consistent within a Bank.

[147] The "x" varies by geographic location.

[148] You must install an IBM Netfinity Fibre Channel PCI Adapter (01K7297) in the server to attach this external fibre-channel RAID controller.

[149] Netfinity 7000 M10 models support external tape drives only.

[150] Requires the 3510020 tape enclosure.

[151] Requires the 3510020 tape enclosure and the 32G3918 Active Terminator.

[152] Requires the 3551001 tape enclosure or the 3503BOX with the 32G3918 Active Terminator.

[153] Uninterruptible power supply (UPS) stated runtimes and power are for typical configurations (70% of maximum capacity).

Option	Part Number	Description
RAID Controller	01K7364	IBM Netfinity ServeRAID-3L Ultra2 SCSI Adapter (1 channel)
RAID Controller	76H3584	IBM ServeRAID II Ultra SCSI Adapter (3 channels)
RAID Controller	35261RU[148]	IBM Netfinity Fibre Channel RAID Controller Unit
SCSI Adapter	02K3454	IBM PCI Fast/Wide Ultra SCSI Adapter
Tape Drive[149]	01K1282[150]	IBM 12/24 GB DDS/3 4mm Internal Drive
Tape Drive[149]	01K1319[150]	IBM 10/20 GB NS SCSI Tape Drive
Tape Drive[149]	01K1325[151]	IBM 20/40 GB 8mm SCSI Tape Drive
Tape Drive[149]	01K1320[152]	IBM 20/40 GB DLT SCSI Tape Drive
Tape Drive[149]	04K0149[152]	IBM 35/70 GB Internal DLT Drive
Terminator	94G7587	Active terminator for internal SCSI cable.
UPS	94G6674[153]	APC Smart-UPS 1400 RMB (12 minute runtime at 525 Volt Amps)
UPS	94G6676[153]	APC Smart-UPS 3000 RMB (35 minute runtime at 525 Volt Amps)

Configuration Tips for the Netfinity 7000 M10

- The Netfinity 7000 M10 backplane supports four hot-swap drive bays. This backplane is connected to one of the two Ultra SCSI controllers on the system board. You can install a ServeRAID adapter to control drives in the hot-swap bays, and then move the internal SCSI cable connector from the Ultra SCSI controller on the system board to an internal channel connector on the ServeRAID adapter.

- When you install multiple hard-disk controllers, RAID controllers, or ServeRAID adapters in the same server, you must install the device that will manage the startup (boot) drives in a PCI slot that is scanned before subsequent hard-disk controllers or RAID adapters. In the Netfinity 7000 M10, the PCI slots are scanned in the following order: PCI bus A, 64-bit expansion slots 1, 2, 3, 4, and 5; PCI bus B, 32-bit expansion slots 6, 7, 8, 9, and 10; then PCI bus C, expansion slots 11 and 12.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID adapters, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

    - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

    - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- You *must* use IBM 10/100 PCI EtherJet Adapters for the cluster's heartbeat connection.

- You *must* use a point-to-point, Category 5 crossover cable for the heartbeat connection. Connections through a hub are not supported.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Selecting the Storage Enclosures

This section contains descriptions of the IBM PC Server 3518 Enterprise Expansion Enclosure, the IBM PC Server 3519 Rack Storage Expansion Enclosure, the IBM Netfinity EXP10 rack storage enclosure, and the recently announced IBM Netfinity EXP15 rack storage enclosure. This section also contains optional-device information and configuration tips for each enclosure.

Standard Features of the Storage Enclosures

The following table provides basic information about the PC Server 3518, the PC Server 3519, the Netfinity EXP10, and the Netfinity EXP15 storage enclosures.

Enclosure	3518	3519	EXP10	EXP15
Form Factor	Tower	Rack Drawer (5U)[154]	Rack Drawer (3U)[154]	Rack Drawer (3U)[154]
Subsystem Type	SCSI	SCSI	Ultra SCSI	Ultra SCSI LVDS
Total Bays	20	9	10	10
Hot-Swap Bays	18	6	10	10
Half-High Device Bays	2	3	0	0
Maximum Internal Storage Capacity	182 GB[155]	72.8 GB[155]	182 GB[155]	182 GB[155]
Power Supply	470 Watt	200 Watt	265 Watt Redundant	350 Watt Redundant
Maximum Weight	119 lb.	60 lb.	92 lb.	92 lb.

IBM PC Server 3518 Enterprise Expansion Enclosure

The PC Server 3518 Enterprise Expansion Enclosure comes with one backplane installed in Bank C. This hot-swap backplane supports up to six slim-line or three half-high hard disk drives. If you want to install more hot-swap drives, you must upgrade the power supply and install one or two additional backplanes.

The maximum storage capacity[155] for one 3518 enclosure is 182 GB. The maximum hot-swap storage capacity for one 3518 enclosure is 163.8 GB.

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[154] 1U is 44.45 mm (1.75 inches).

[155] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

Optional Devices Supported on the PC Server 3518

The following table provides information about the optional devices available for the PC Server 3518 Enterprise Expansion Enclosure.

Option	Part Number	Description
Backplane	76H2670[156]	IBM PC Server Hot-Swap Backplane III
Cable	94G4070	Backplane-to-Backplane Cable (used to daisy chain two backplanes together to form one continuous SCSI bus)
Cable	70G9876	Backplane Cable (used to connect a backplane to a repeater card or to the rear-panel knockout)
Cable	70G9864	Backplane-to-Media-Bay Cable (This cable is used to connect a 5.25-inch device in bays B1 or B2 to share the SCSI channel for the hot-swap bays. A 68-to-50 pin converter (32G3925) comes with this cable.)
Cable	70G9877	Media-Bay Cable (This cable is used to connect a 5.25-inch device in bays B1 or B2 to the rear of the enclosure so that it can use a dedicated SCSI channel. A 68-to-50 pin converter (32G3925) comes with this cable.
Convenience Kit	94G7584	Shared Disk Convenience Kit. This kit contains: • 1 76H2670 Hot-Swap Backplane III • 2 94G7585 SCSI-2 Fast/Wide Enhanced Repeaters • 1 94G7593 Power Supply Upgrade II option • 2 86H2432 IBM 100/10 PCI EtherJet Adapters • 2 94G4070 Backplane-to-Backplane cable • 1 70G9876 Expansion Enclosure Backplane Cable • 1 76H0551[157] Ethernet Crossover cable • 2 01K8029 4.3 Meter External 68-pin SCSI Cable
Hard Disk Drive	70G9862[158]	2.25 GB, SCSI-2 F/W, hot-swap
Hard Disk Drive	94G7491[158]	4.5 GB, Wide Ultra SCSI[159], hot-swap
Hard Disk Drive	94G7492[160]	9.1 GB Wide Ultra SCSI[159], hot-swap
Hard Disk Drive	02K0477	9.1 GB Wide Ultra SCSI[159], hot-swap (slim line)
Hard Disk Drive	76H2689[161]	9.1 GB Wide Ultra SCSI[159] (half high)
Power Supply	94G7593	PC Server Power Supply Upgrade II
Power Supply	94G4701	780 Watt Redundant Power Option
Repeater	94G7585[162]	PC Server SCSI-2 Fast/Wide Enhanced Repeater
Security	70G9742	PC Server Security Cover
Tape Drive	74G8631[163]	4/10 GB 5.25-inch DAT Tape Kit
UPS	94G3135	APC Smart-UPS 1000
UPS	94G3136	APC Smart-UPS 1400

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[156] You must have a power-supply upgrade installed (either 94G7593 or 94G4701) to support multiple backplanes.

[157] This cable is not available for separate purchase. This Category 5 cable is designed for point-to-point connections and has RJ-45 connectors on each end.

[158] Each Bank supports up to six of these drives, for a maximum of 18 drives per enclosure.

[159] You must configure Ultra SCSI drives to operate at SCSI-2 speeds in this enclosure.

[160] Each Bank supports up to three of these half-high drives, for a maximum of nine drives per enclosure.

[161] You can install this drive in bay B1 or bay B2.

[162] The older model of the repeater (Part Number 94G5565) is not supported in cluster configurations.

[163] Requires a 68-pin to 50-pin converter (IBM Part Number 32G3925) and a Media-Bay Cable (IBM Part Number 70G9864 or 70G9877).

Configuration Tips for the PC Server 3518

- Before you install an additional backplane, be sure to set its jumpers. You must set the jumper that designates the backplane bank as D or E. You also can change the SCSI-ID jumper from its default setting for low addressing (0, 1, 2, 3, 4, 5) to high addressing (8, 9, 10, 11, 12, 13) or to reverse addressing (5, 4, 3, 2, 1, 0).

- If you want to daisy chain two backplanes together and install slim-line drives in both banks (C and D), you must set the SCSI-ID jumper of the backplane in Bank D for high addressing (8 to 13). If you want to daisy chain two backplanes together and install half-high drives in both banks (C and D), you must set the SCSI-ID jumper of the backplane in Bank D to reverse addressing (5, 3, 1), or to high addressing (8, 10, 12). This will help prevent SCSI address conflicts.

- You must use the Fast/Wide Enhanced Repeater (card part number 07L8392) provided in option Part Number 94G7585. The older model SCSI repeater (option Part Number 94G5565) is not supported in cluster configurations.

- Before you install an Enhanced SCSI Repeater, be sure to review the documentation provided with the repeater and verify that its jumpers are set properly for your specific configuration.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID II adapter, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

IBM PC Server 3519 Rack Storage Expansion Enclosure

You can install the PC Server 3519 Rack Storage Expansion Enclosure in an IBM Netfinity Rack or in an industry-standard, 19-inch rack that meets EIA-310-D standards and has a minimum depth of 71.12 cm (28 inches).

The maximum storage capacity[164] for one PC Server 3519 enclosure is 72.8 GB, using six 9.1 GB hot-swap drives and two 9.1 GB non-hot-swap drives.

Optional Devices Supported on the PC Server 3519

The following table provides information about the optional devices available for the PC Server 3519 Rack Storage Expansion Enclosure.

Option	Part Number	Description
Cable	70G9876	Expansion Enclosure Backplane Cable
Cable	94G7594	IBM SCSI Storage Extender Cable[165]
Cable	94G5567	IBM PC Server 3.0 Meter SCSI-2 Fast/Wide Cable
Cable	94G5566	IBM PC Server 4.3 Meter SCSI-2 Rack Cable[166]
Cable	01K8028	IBM 3M External .8mm SCSI Cable
Cable	01K8029	IBM PC Server 4.3M External .8mm SCSI Cable
Hard Disk Drive	70G9862	2.25 GB, SCSI-2 F/W, Hot-Swap
Hard Disk Drive	94G7491	4.51 GB Wide Ultra SCSI[167] Hot-Swap
Hard Disk Drive	94G7492	9.10 GB Wide Ultra SCSI[167] Hot-Swap
Hard Disk Drive	02K0477	9.10 GB Wide Ultra SCSI Hot-Swap (slim line)
Hard Disk Drive	76H2689	Ultrastar 9.1 GB Wide Ultra SCSI[167] (half high[168])
Rack	9306900	IBM Netfinity Rack
Repeater	94G7585[169]	PC Server SCSI-2 Fast/Wide Enhanced Repeater
Tape Drive	74G8631[170]	4/10 GB 5.25-inch DAT Tape Kit

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[164] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[165] Allows daisy chaining of two 3519s from a single controller. The cable is 6 meters long with a connector in the middle, 3 meters from each end.

[166] Only supported for use in rack configurations.

[167] You must configure Ultra SCSI drives to operate at SCSI-2 speed in this enclosure.

[168] You can install up to two half-high drives in bays 1 to 3. Bay 2 must remain empty when two of these drives are installed.

[169] The older model of the repeater (Part Number 94G5565) is not supported in cluster configurations.

[170] Requires a 68-pin to 50-pin converter, IBM Part Number 32G3925.

Configuration Tips for the PC Server 3519

- You must use the Fast/Wide Enhanced Repeater (card part number 07L8392) provided in option Part Number 94G7585. The older model SCSI repeater (option Part Number 94G5565) is not supported in cluster configurations.

- Before you install an Enhanced SCSI Repeater, be sure to review the documentation provided with the repeater and verify that its jumpers are set properly for your specific configuration.

- Before you install hot-swap drives, be sure to review the documentation provided with the enclosure and verify that the jumper settings on the backplane are set properly for your specific environment. As shipped, the SCSI ID jumper (J12) is set for HI addressing and reverse IDs, which results in SCSI ID assignments of 13 to 8 in bays 4 through 9 respectively.

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID II adapter, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

  - When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

  - When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

IBM Netfinity EXP10 Rack Storage Enclosure

You can install the Netfinity EXP10 rack storage enclosure in an IBM Netfinity Rack or in an industry-standard, 19-inch rack that meets EIA-310-D standards and has a minimum depth of 71.12 cm (28 inches).

This compact rack enclosure (3U) supports up to 10 hot-swap drives for a maximum storage capacity[171] of 182 GB.

Optional Devices Supported on the Netfinity EXP10

The following table provides information about the optional devices available for the Netfinity EXP10 storage enclosure.

Option	Part Number	Description
Hard Disk	01K7956[173]	4.51 GB Wide Ultra SCSI SCA-2
Hard Disk	01K7960[173]	4.51 GB 10K Wide Ultra SCSI SCA-2
Hard Disk	01K7968[172]	9.1 GB 10K Wide Ultra SCSI SCA-2
Hard Disk	01K7959[173]	9.1 GB Wide Ultra SCSI SCA-2
Hard Disk	01K8499[173]	9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk	01K8500[172]	18.2 GB Wide Ultra SCSI SCA-2
Hard Disk	01K8501[173]	18.2 GB 10K Wide Ultra SCSI SCA-2
SCSI Cable	03K9352	Netfinity EXP10 3.0 Meter External Auto-Sensing Cable
SCSI Cable	94G5567	PC Server 3.0M SCSI-2 Fast/Wide Cable
SCSI Cable	94G5566	PC Server 4.3M SCSI-2 Fast/Wide Rack Cable
SCSI Cable	01K8027	IBM 2M External .8mm SCSI Cable
SCSI Cable	01K8029	IBM 4.3M External .8mm SCSI Cable
Terminator	32G3918	SCSI-2 16-bit Active Terminator

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[171] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[172] To maintain proper cooling and power distribution, **do not** install more than eight of these drives in the enclosure. Bays 5 and 6 *must* remain empty when using these drives.

[173] You can install up to ten of these drives in each enclosure.

Configuration Tips for the Netfinity EXP10

- You must use SCSI-2 Fast/Wide modes in clustered environments; Ultra SCSI modes are not supported.

- Ensure that switch 3 on the options-switch block is in the On (or up-right) position. This enables the ServeRAID adapter to control the spin up of the drives. Otherwise, the load of all drives simultaneously powering up could cause an overload condition and cause the power supplies to shut themselves off.

- When configured as a single SCSI bus, the drive SCSI ID assignments alternate between low and high addresses. When configured as two independent SCSI buses, duplicate SCSI IDs are assigned to the drives. In certain configurations, this might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. The SCSI ID assignments from left (bay 1) to right (bay 10) are as follows:

    As a single, ten drive SCSI bus: 0 8 1 9 2 10 3 11 4 12
    As two, five drive SCSI buses: 0 0 1 1 2 2 3 3 4 4

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID II adapter, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

    – When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

    – When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

IBM Netfinity EXP15 Rack Storage Enclosure

You can install the Netfinity EXP15 rack storage enclosure in an IBM Netfinity NetBAY3, in an IBM Netfinity Rack, or in an industry-standard 19-inch rack that meets EIA-310-D standards and has a minimum depth of 71.12 cm (28 inches).

This compact rack enclosure (3U) supports up to 10 hot-swap drives for a maximum storage capacity[174] of 182 GB.

Optional Devices Supported on the Netfinity EXP15

The following table provides information about the optional devices available for the Netfinity EXP15 storage enclosure.

Option	Part Number	Description
Hard Disk	01K7956[175]	4.51 GB Wide Ultra SCSI SCA-2
Hard Disk	01K7960[175]	4.51 GB 10K Wide Ultra SCSI SCA-2
Hard Disk	01K7968[175]	9.1 GB 10K Wide Ultra SCSI SCA-2
Hard Disk	01K7959[175]	9.1 GB Wide Ultra SCSI SCA-2
Hard Disk	01K8499[175]	9.1 GB 10K Wide Ultra SCSI SCA-2 (slim line)
Hard Disk	01K8500[175]	18.2 GB Wide Ultra SCSI SCA-2
Hard Disk	01K8501[175]	18.2 GB 10K Wide Ultra SCSI SCA-2
SCSI Cable	03K9352[176]	Netfinity EXP10 3.0 Meter External Auto-Sensing Cable
SCSI Cable	03K9310	Netfinity 2M Ultra2 SCSI (LVDS)
SCSI Cable	03K9311[176]	Netfinity 4.2M Ultra2 SCSI (LVDS)
SCSI Cable	03K9312[177]	Netfinity 12M Ultra2 SCSI (LVDS)
SCSI Cable	76H3589	IBM 1M External SCSI (.8mm)
SCSI Cable	01K8027	IBM 2M External SCSI (.8mm)
SCSI Cable	01K8029[176]	IBM 4.3M External SCSI (.8mm)
Terminator	32G3918	SCSI-2 16-bit Active Terminator

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[174] This figure represents raw-storage capacity. Several factors influence the actual amount of useable-storage capacity, such as the drive's capacity and the RAID levels assigned.

[175] You can install up to ten of these drives in each enclosure.

[176] Cable lengths exceeding 2 meters are limited to the SCSI Fast/Wide speed of 20 MB/sec.

[177] Cable lengths exceeding 4.3M are supported only when attached to an LVDS controller.

Configuration Tips for the Netfinity EXP15

- When connecting a Netfinity EXP15 to an IBM ServeRAID adapter in a clustered environment, you must configure all ten drive bays as a single SCSI bus. To configure the Netfinity EXP15 drive bays as a single SCSI bus, set Option Switch 1 to the Off or down position.

- When connecting a Netfinity EXP15 to a Netfinity Fibre Channel RAID Controller in a clustered environment, you can configure the drive bays as a ten-drive SCSI bus, or as two five-drive SCSI buses. To configure the Netfinity EXP15 as a ten-drive SCSI bus, set Option Switch 1 to the Off or down position. To configure the Netfinity 15 as two, five-drive SCSI buses, set Option Switch 1 to the On or up position.

- When configured as a single SCSI bus, the drive SCSI ID assignments alternate between low and high addresses. When configured as two independent SCSI buses, duplicate SCSI IDs are assigned to the drives. In certain configurations, this might cause some confusion. To avoid confusion with the SCSI IDs, consider placing a label with the SCSI IDs across the front of the drive bays. The SCSI ID assignments from left (bay 1) to right (bay 10) are as follows:

    As a single, ten-drive SCSI bus: 0 8 1 9 2 10 3 11 4 12
    As two, five-drive SCSI buses: 0 0 1 1 2 2 3 3 4 4

- Each ServeRAID adapter supports up to eight logical drives. If a failure occurs, the remaining ServeRAID adapter will need to support its own logical drives and the logical drives of its counterpart in the failing server. Therefore, the total number of shared logical drives for each set of ServeRAID adapters must not exceed eight. A good way to ensure that you do not exceed this limit would be to define no more than four logical drives for each ServeRAID adapter.

- With the ServeRAID II adapter, you can set the stripe-unit size to 8 K (the default), 16 K, 32 K, or 64 K. After you set a stripe-unit size and store data on the logical drives, you cannot change the size without destroying data in the logical drives. Both adapters in a pair must use the same stripe-unit size.

    – When the stripe-unit size is set to 8 K or 16 K, the maximum number of physical hard disk drives in an array is 16.

    – When the stripe-unit size is set to 32 K or 64 K, the maximum number of physical hard disk drives in an array is eight.

- When using the Vinca High Availability for NetWare program, refer to the NetWare documentation for information about calculating the amount of system memory needed to support the number and capacity of hard disk drives you intend to install.

Selecting the Rack Enclosures

You can store multiple servers, storage enclosures, and optional devices in a rack enclosure. Rack enclosures significantly reduce the amount of floor space required, and they enable you to safely manage your clustered hardware and cabling.

The *IBM Server Paper Configurator Guide* provides detailed specifications and configuration information about the available IBM rack enclosures. You can download an up-to-date copy of this document from the following World Wide Web page:

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http://www.pc.ibm.com/us/products/server/download.html
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To obtain additional information about IBM rack enclosures, contact your marketing representative.

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Printed in U.S.A.