ESCALA Power7

SAS RAID controllers for AIX

ESCALA Models Reference

The ESCALA Power7 publications concern the following models:

Bull Escala E1-700 / E3-700	(31E/2B ,8231-E2B)
Bull Escala E1-705	(31E/1C, 8231-E1C)
Bull Escala E1-715	(31E/1D, 8231-E1D)
Bull Escala E3-705	(31E/2C, 8231-E2C)
Bull Escala E3-715	(31E/2D, 8231-E2D)
Bull Escala E2-700 / E2-700T	(02E/4B, 8202-E4B)
Bull Escala E2-705 / E2-705T	(02E/4C, 8202-E4C)
Bull Escala E2-715 / E2-715T	(02E/4D, 8202-E4D)
Bull Escala E4-700 / E4-700T	(05F/6B, 8205-E6B)
Bull Escala E4-705	(05E/6C, 8205-E6C)
Bull Escala E4-715	(05E/6D, 8205-E6D)
Bull Escala E5-700	(33E/8B, 8233-E8B)
Bull Escala E5-715	(08E/8D, 8408-E8D)
Bull Escala M5-715	(09R/MD, 9109-RMD)
Bull Escala M6-700	(17M/MB, 9117-MMB)
Bull Escala M6-705	(17M/MC, 9117-MMC)
Bull Escala M6-715	(17M/MD, 9117-MMD)
Bull Escala M7-700	(79M/HB, 9179-MHB)
Bull Escala M7-705	(79M/HC, 9179-MHC)
Bull Escala M7-715	(79M/HD, 9179-MHD)
Bull Escala H9-700	(19F/HB, 9119-FHB)

References to 8236-E8C models are irrelevant.

Hardware

February 2013

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All brand names and software and hardware product names are subject to trademark and/or patent protection.

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Contents

Safety notices

Safety notices may be printed throughout this guide:

- **DANGER** notices call attention to a situation that is potentially lethal or extremely hazardous to people.
- **CAUTION** notices call attention to a situation that is potentially hazardous to people because of some existing condition.
- **Attention** notices call attention to the possibility of damage to a program, device, system, or data.

World Trade safety information

Several countries require the safety information contained in product publications to be presented in their national languages. If this requirement applies to your country, a safety information booklet is included in the publications package shipped with the product. The booklet contains the safety information in your national language with references to the U.S. English source. Before using a U.S. English publication to install, operate, or service this product, you must first become familiar with the related safety information in the booklet. You should also refer to the booklet any time you do not clearly understand any safety information in the U.S. English publications.

German safety information

Das Produkt ist nicht für den Einsatz an Bildschirmarbeitsplätzen im Sinne § 2 der Bildschirmarbeitsverordnung geeignet.

Laser safety information

IBM® servers can use I/O cards or features that are fiber-optic based and that utilize lasers or LEDs.

Laser compliance

IBM servers may be installed inside or outside of an IT equipment rack.

DANGER

When working on or around the system, observe the following precautions:

Electrical voltage and current from power, telephone, and communication cables are hazardous. To avoid a shock hazard:
- **Connect power to this unit only with the IBM provided power cord. Do not use the IBM provided power cord for any other product.**
- **Do not open or service any power supply assembly.**
- **Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.**
- **The product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords.**
- **Connect all power cords to a properly wired and grounded electrical outlet. Ensure that the outlet supplies proper voltage and phase rotation according to the system rating plate.**
- **Connect any equipment that will be attached to this product to properly wired outlets.**
- **When possible, use one hand only to connect or disconnect signal cables.**
- **Never turn on any equipment when there is evidence of fire, water, or structural damage.**
- **Disconnect the attached power cords, telecommunications systems, networks, and modems before you open the device covers, unless instructed otherwise in the installation and configuration procedures.**
- **Connect and disconnect cables as described in the following procedures when installing, moving, or opening covers on this product or attached devices.**

  To Disconnect:
  1. **Turn off everything (unless instructed otherwise).**
  2. **Remove the power cords from the outlets.**
  3. **Remove the signal cables from the connectors.**
  4. **Remove all cables from the devices.**

  To Connect:
  1. **Turn off everything (unless instructed otherwise).**
  2. **Attach all cables to the devices.**
  3. **Attach the signal cables to the connectors.**
  4. **Attach the power cords to the outlets.**
  5. **Turn on the devices.**

  (D005)

DANGER

Observe the following precautions when working on or around your IT rack system:

- Heavy equipment–personal injury or equipment damage might result if mishandled.
- Always lower the leveling pads on the rack cabinet.
- Always install stabilizer brackets on the rack cabinet.
- To avoid hazardous conditions due to uneven mechanical loading, always install the heaviest devices in the bottom of the rack cabinet. Always install servers and optional devices starting from the bottom of the rack cabinet.
- Rack-mounted devices are not to be used as shelves or work spaces. Do not place objects on top of rack-mounted devices.

- Each rack cabinet might have more than one power cord. Be sure to disconnect all power cords in the rack cabinet when directed to disconnect power during servicing.
- Connect all devices installed in a rack cabinet to power devices installed in the same rack cabinet. Do not plug a power cord from a device installed in one rack cabinet into a power device installed in a different rack cabinet.
- An electrical outlet that is not correctly wired could place hazardous voltage on the metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock.

CAUTION

- Do not install a unit in a rack where the internal rack ambient temperatures will exceed the manufacturer's recommended ambient temperature for all your rack-mounted devices.
- Do not install a unit in a rack where the air flow is compromised. Ensure that air flow is not blocked or reduced on any side, front, or back of a unit used for air flow through the unit.
- Consideration should be given to the connection of the equipment to the supply circuit so that overloading of the circuits does not compromise the supply wiring or overcurrent protection. To provide the correct power connection to a rack, refer to the rating labels located on the equipment in the rack to determine the total power requirement of the supply circuit.
- *(For sliding drawers.)* Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.
- *(For fixed drawers.)* This drawer is a fixed drawer and must not be moved for servicing unless specified by the manufacturer. Attempting to move the drawer partially or completely out of the rack might cause the rack to become unstable or cause the drawer to fall out of the rack.

(R001)

CAUTION:

Removing components from the upper positions in the rack cabinet improves rack stability during relocation. Follow these general guidelines whenever you relocate a populated rack cabinet within a room or building:

- Reduce the weight of the rack cabinet by removing equipment starting at the top of the rack cabinet. When possible, restore the rack cabinet to the configuration of the rack cabinet as you received it. If this configuration is not known, you must observe the following precautions:
  - Remove all devices in the 32U position and above.
  - Ensure that the heaviest devices are installed in the bottom of the rack cabinet.
  - Ensure that there are no empty U-levels between devices installed in the rack cabinet below the 32U level.
- If the rack cabinet you are relocating is part of a suite of rack cabinets, detach the rack cabinet from the suite.
- Inspect the route that you plan to take to eliminate potential hazards.
- Verify that the route that you choose can support the weight of the loaded rack cabinet. Refer to the documentation that comes with your rack cabinet for the weight of a loaded rack cabinet.
- Verify that all door openings are at least 760 x 230 mm (30 x 80 in.).
- Ensure that all devices, shelves, drawers, doors, and cables are secure.
- Ensure that the four leveling pads are raised to their highest position.
- Ensure that there is no stabilizer bracket installed on the rack cabinet during movement.
- Do not use a ramp inclined at more than 10 degrees.
- When the rack cabinet is in the new location, complete the following steps:
  - Lower the four leveling pads.
  - Install stabilizer brackets on the rack cabinet.
  - If you removed any devices from the rack cabinet, repopulate the rack cabinet from the lowest position to the highest position.
- If a long-distance relocation is required, restore the rack cabinet to the configuration of the rack cabinet as you received it. Pack the rack cabinet in the original packaging material, or equivalent. Also lower the leveling pads to raise the casters off of the pallet and bolt the rack cabinet to the pallet.

(R002)

(L001)

(L002)

(L003)
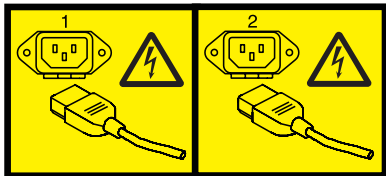
or

All lasers are certified in the U.S. to conform to the requirements of DHHS 21 CFR Subchapter J for class 1 laser products. Outside the U.S., they are certified to be in compliance with IEC 60825 as a class 1 laser product. Consult the label on each part for laser certification numbers and approval information.

CAUTION:
This product might contain one or more of the following devices: CD-ROM drive, DVD-ROM drive, DVD-RAM drive, or laser module, which are Class 1 laser products. Note the following information:
- **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**
- **Use of the controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.**

(C026)

CAUTION:
Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. (C027)

CAUTION:
This product contains a Class 1M laser. Do not view directly with optical instruments. (C028)

CAUTION:
Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following information: laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam. (C030)

CAUTION:
The battery contains lithium. To avoid possible explosion, do not burn or charge the battery.

Do Not:
- ___ **Throw or immerse into water**
- ___ **Heat to more than 100°C (212°F)**
- ___ **Repair or disassemble**

Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call. (C003)

Power and cabling information for NEBS (Network Equipment-Building System) GR-1089-CORE

The following comments apply to the IBM servers that have been designated as conforming to NEBS (Network Equipment-Building System) GR-1089-CORE:

The equipment is suitable for installation in the following:
- Network telecommunications facilities
- Locations where the NEC (National Electrical Code) applies

The intrabuilding ports of this equipment are suitable for connection to intrabuilding or unexposed wiring or cabling only. The intrabuilding ports of this equipment *must not* be metallically connected to the interfaces that connect to the OSP (outside plant) or its wiring. These interfaces are designed for use as intrabuilding interfaces only (Type 2 or Type 4 ports as described in GR-1089-CORE) and require isolation from the exposed OSP cabling. The addition of primary protectors is not sufficient protection to connect these interfaces metallically to OSP wiring.

Note: All Ethernet cables must be shielded and grounded at both ends.

The ac-powered system does not require the use of an external surge protection device (SPD).

The dc-powered system employs an isolated DC return (DC-I) design. The DC battery return terminal *shall not* be connected to the chassis or frame ground.

SAS RAID controllers for AIX

Use this information to learn about the usage and maintenance of the SAS RAID controllers for the AIX® operating system.

SAS RAID controllers for AIX overview

Find usage and maintenance information regarding controllers for the serial-attached SCSI (SAS) Redundant Array of Independent Disks (RAID) for the AIX operating system. Use this information in conjunction with your specific system unit and operating system documentation. General information is intended for all users of this product. Service information is intended for a service representative specifically trained on the system unit and subsystem being serviced.

The SAS RAID controllers for AIX have the following features:

- PCI-X 266 system interface or PCI Express (PCIe) system interface.
- Physical link (phy) speed of 3 Gbps SAS supporting transfer rates of 300 MB per second on PCI-X and PCIe controllers.
- Physical link (phy) speed of 6 Gbps SAS supporting transfer rates of 600 MB per second on PCI Express 2.0 (PCIe2) controllers.
- Supports SAS devices and non-disk Serial Advanced Technology Attachment (SATA) devices.
- Optimized for SAS disk configurations that use dual paths through dual expanders for redundancy and reliability.
- Controller managed path redundancy and path switching for multiported SAS devices.
- Embedded PowerPC® RISC Processor, hardware XOR DMA Engine, and hardware Finite Field Multiplier (FFM) DMA Engine (for Redundant Array of Independent Disks (RAID) 6).
- Support nonvolatile write cache for RAID disk arrays on some adapters (PCIe2 controllers feature Flash-Backed-DRAM which eliminates the need for rechargeable batteries).
- Support for RAID 0, 5, 6, and 10 disk arrays.
- Supports attachment of other devices such as non-RAID disks, tape, and optical devices.
- RAID disk arrays and non-RAID devices supported as a bootable device.
- Advanced RAID features:
  - Hot spares for RAID 5, 6, and 10 disk arrays
  - Ability to increase the capacity of an existing RAID 5 or 6 disk array by adding disks (not available on PCIe2 controllers)
  - Background parity checking
  - Background data scrubbing
  - Disks formatted to 528 bytes per sector, providing cyclical redundancy checking (CRC) and logically bad block checking on PCI-X and PCIe controllers
  - Disks formatted to 528 bytes per sector, providing SCSI T10 standardized data integrity fields along with logically bad block checking on PCIe2 controllers
  - Optimized hardware for RAID 5 and 6 sequential write workloads
  - Optimized skip read/write disk support for transaction workloads
- Supports a maximum of 64 advanced function disks with a total device support maximum of 255 (the number of all physical SAS and SATA devices plus the number of logical RAID disk arrays must be less than 255 per controller) on PCI-X and PCIe controllers.
- Supports a maximum of 240 advanced function disks with a total device support maximum of 1023 (the number of all physical SAS and SATA devices plus the number of logical RAID disk arrays must be less than 1023 per controller) on PCIe2 controllers.

Feature comparison of SAS RAID cards

Compare the main features of PCI-X, PCI Express (PCIe), and PCIe2 SAS RAID cards.

3

These tables provides a breakdown of the main features of the SAS RAID PCI-X and PCIe controller cards.

PCI-X SAS RAID card comparison

This table compares the main features of PCI-X SAS RAID cards.

Table 1. PCI-X SAS RAID controller cards

CCIN (custom card identification number)	2BD9	2BE0	2BE1	572A	572B	572C	572F / 575C	57B8
Description	PCI-X266 Planar 3 Gb SAS RAID Adapter (RAID/Cache Storage Controller)	PCI-X266 Planar 3 Gb SAS Adapter (RAID-10 Storage Controller)	PCI-X266 Planar 3 Gb SAS RAID Adapter (RAID/Cache Enablement)	PCI-X 266 Ext Dual-x4 3 Gb SAS Adapter	PCI-X 266 Ext Dual-x4 3 Gb SAS RAID Adapter	PCI-X 266 Planar 3 Gb SAS Adapter	PCI-X 266 Ext Tri-x4 3 Gb SAS RAID Adapter	PCI-X 266 Planar 3 Gb SAS RAID Adapter
Form factor	Planar unique 64-bit PCI-X	Planar unique 64-bit PCI-X	Planar RAID enablement	Low profile 64-bit PCI-X	Long 64-bit PCI-X	Planar integrated	Long 64-bit PCI-X, double-wide card set	Planar RAID enablement
Adapter failing function code LED value	2D18	2D16	2D17	2515	2517	2502	2519 / 251D	2505
Physical links	6 (two 2x wide ports to shared SAS Drives and one 2x wide port to 2BE1 adapter)	3 (Direct attach SAS Drives)	8 (two 2x wide ports to shared SAS Drives, one 2x wide port to 2BD9 adapter, one phy to DVD, and optionally one physical link to Tape Drive)	8 (two mini SAS 4x connectors)	8 (two mini SAS 4x connectors)	8[1]	12 (bottom 3 mini SAS 4x connectors) and 2 (top mini SAS 4x connector for HA only)	8[1]
RAID levels supported	RAID 0, 5, 6, 10	RAID 0, 5[4], 10	RAID 0, 5, 6, 10	RAID 0, 5[4], 6[4], 10	RAID 0, 5, 6, 10	RAID 0	RAID 0, 5, 6, 10	RAID 0, 5, 6, 10
Adding disks to an existing disk array supported RAID levels	RAID 5, 6	RAID 5	RAID 5, 6	RAID 5, 6	RAID 5, 6		RAID 5, 6	RAID 5, 6
Write cache size	175 MB		175 MB		175 MB		Up to 1.5 Gb (compressed)	175 MB
Read cache size							Up to 1.6 Gb (compressed)	
Cache battery pack technology	LiIon		LiIon		LiIon		LiIon	Not applicable[2]
Cache battery pack FFC	2D1B		2D1B		2D03		2D06[5]	Not applicable[2]
Cache battery concurrent maintenance	No	No	No	No	No	No	Yes	Not applicable[2]
Cache data present LED	Yes	No	Yes	No	No	No	No	No
Removable cache card	No	No	No	No	Yes	No	No	No
Auxiliary write cache (AWC) support	No	No	No	No	No	No	Yes	Yes
High availability (HA) two system RAID	Yes	No	Yes	Yes[3]	Yes	No	No	No
HA two system JBOD	No	No	No	Yes[3]	No	No	No	No

Table 1. PCI-X SAS RAID controller cards (continued)

CCIN (custom card identification number)	2BD9	2BE0	2BE1	572A	572B	572C	572F / 575C	57B8
HA single system RAID	Yes	No	Yes	Yes[3]	Yes	No	No	No
Requires HA RAID configuration	Yes	No	Yes	No	Yes	No	No	No
JBOD support	No	Yes	No	Yes	No	Yes	No	Yes

[1] Some systems provide an external mini SAS 4x connector from the integrated backplane controller.

[2] The controller contains battery-backed cache, but the battery power is supplied by the 57B8 controller through the backplane connections.

[3] Multi-initiator and high availability is supported on the CCIN 572A adapter except for part numbers of either 44V4266 or 44V4404 (feature code 5900).

[4] The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6, or use solid-state drives (SSDs) where supported to improve write performance.

[5] The cache battery pack for both adapters is contained in a single battery field-replaceable unit (FRU), which is physically located on the 575C auxiliary cache card.

[6] Nonvolatile write cache is supported for RAID disk arrays only.
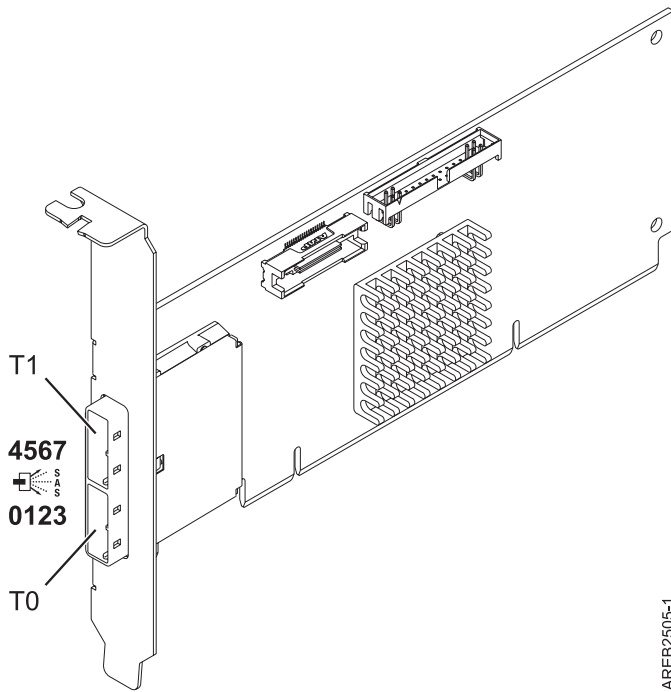
Figure 1. CCIN 572A PCI-X266 External Dual-x4 3 Gb SAS adapter
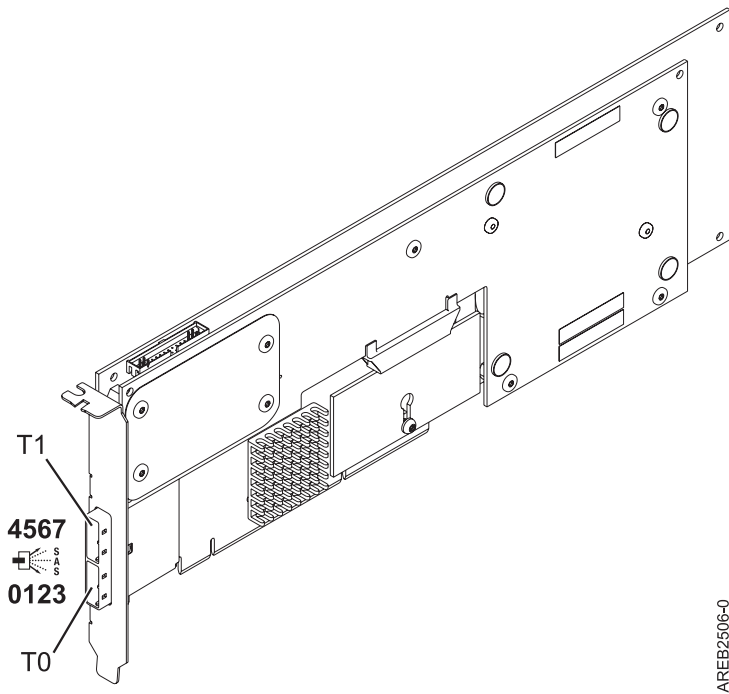
Figure 2. CCIN 572B PCI-X266 Ext Dual-x4 3 Gb SAS RAID adapter
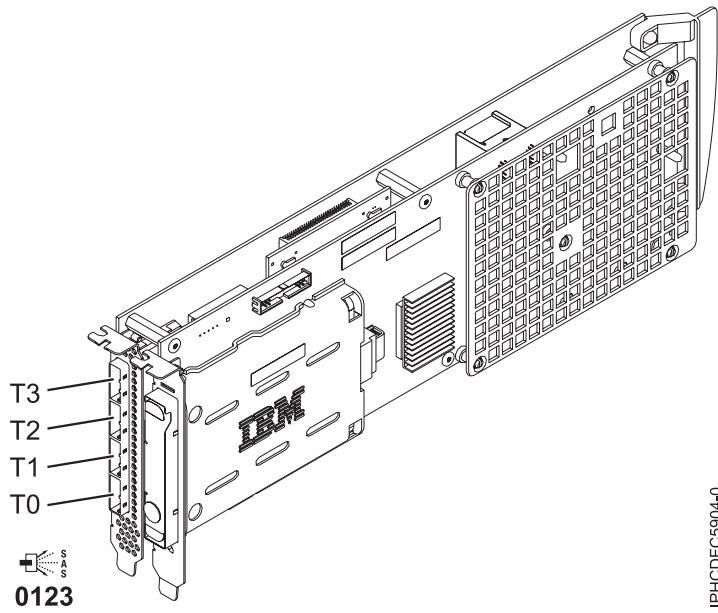
Figure 3. CCIN 572F PCI-X266 Ext Tri-x4 3 Gb SAS RAID adapter and CCIN 575C PCI-X266 auxiliary cache adapter
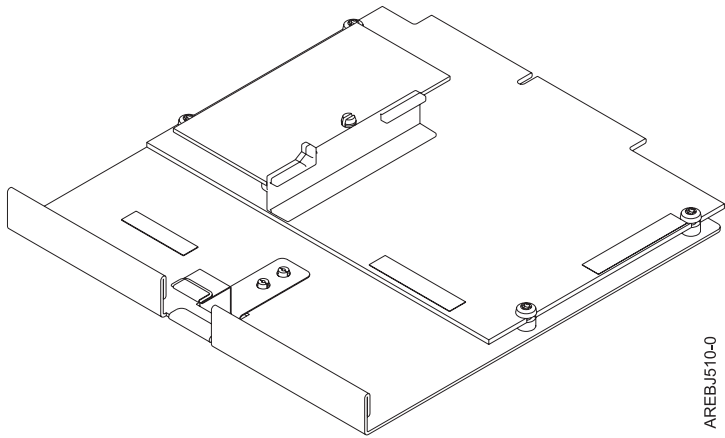
AREBJ510-0

Figure 4. CCIN 57B8 planar RAID enablement card

RAID/Cache Enablement
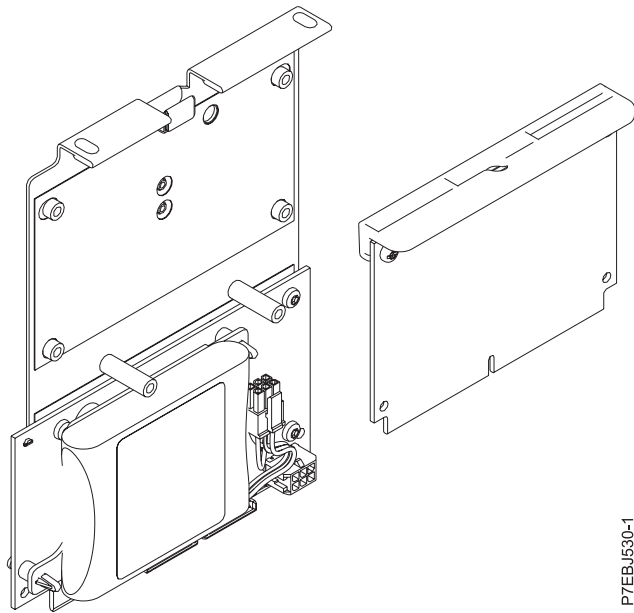
P7EBJ530-1

Figure 5. CCIN 2BE1 PCI-X266 Planar 3 Gb SAS Adapter

Planar RAID 10 Storage Controller
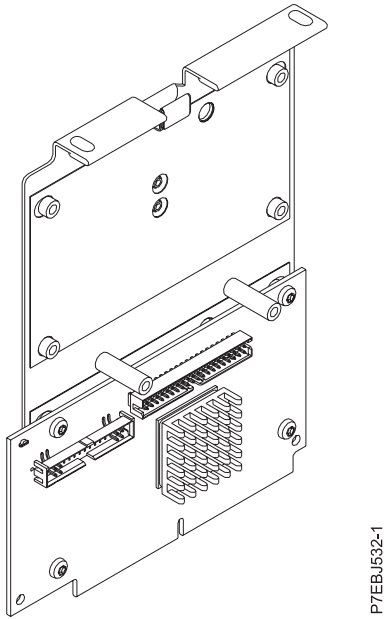
Figure 6. CCIN 2BE0 PCI-X266 Planar 3 Gb SAS Adapter

Planar RAID/Cache Storage Controller
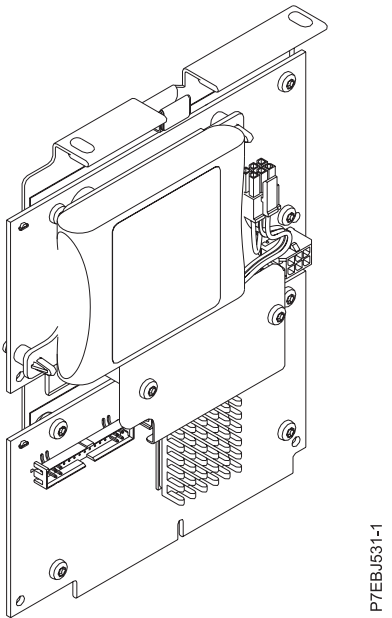
Figure 7. CCIN 2BD9 PCI-X266 Planar 3 Gb SAS RAID Adapter

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PCIe SAS RAID card comparison

Use the tables provided here to compare the main features of PCI Express (PCIe) SAS RAID cards.

Table 2. PCIe SAS RAID controller cards

CCIN (custom card identification number)	2B4C	2B4F	574E	57B3	57B7	57B9
Description	PCIe x4 Internal 3 Gb SAS RAID Adapter	PCIe x4 Internal 3 Gb SAS Adapter	PCIe x8 Ext Dual-x4 3 Gb SAS RAID Adapter	PCIe x8 Ext Dual-x4 3 Gb SAS Adapter	PCIe x1 Auxiliary Cache Adapter	PCIe x8 Ext Dual-x4 3 Gb SAS Adapter and Cable Card
Form factor	Planar-unique PCIe	Planar-unique PCIe	PCIe x8	PCIe x8	Planar Auxiliary Cache	Combination PCIe x8 and Cable Card
Adapter failing function code LED value	2D28	2D27	2518	2516	2504	2D0B
Physical links	6 (two 2x wide ports to shared SAS drives and one 2x wide port to 57CB)	3 (Directly attached SAS drives)	8 (two mini SAS 4x connectors)	8 (two mini SAS 4x connectors)	2	4 (bottom mini-SAS 4x connector required to connect by an external AI cable to the top mini-SAS 4x Cable Card connector)
RAID levels supported	RAID 0, 5, 6, 10	RAID 0, 5[1], 10	RAID 0, 5, 6, 10	RAID 0, 5[1], 6[1], 10		RAID 0, 5[1], 6[1], 10
Adding disks to an existing disk array supported RAID levels	RAID 5, 6	RAID 5	RAID 5, 6	RAID 5, 6		RAID 5, 6
Write cache size[4]	175 MB		380 MB		175 MB	
Read cache size						
Cache battery pack technology	LiIon		LiIon		LiIon	
Cache battery pack FFC	2D1B		2D0E		2D05	
Cache battery concurrent maintenance	No	No	Yes	No	Yes	No
Cache data present LED	Yes	No	Yes	No	Yes	No
Removable cache card	No	No	Yes	No	No	No
Auxiliary write cache (AWC) support	No	No	No	No	Yes	No
High availability (HA) two system RAID	Yes	No	Yes	Yes	No	No
HA two system JBOD	No	No	No	Yes	No	No
HA single system RAID	Yes	No	Yes	Yes	No	No
Requires HA RAID configuration	Yes	No	Yes	No	No	No
JBOD support	No	Yes	No	Yes	No	Yes

[1] The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6 or use solid-state drives (SSDs) where supported to improve write performance.

[2] RAID 0 requires the use of AIX logical value manager (LVM) mirroring.

[3] The integrated SSDs are allowed to run in JBOD mode.

[4] Nonvolatile write cache is supported only for RAID disk arrays.

Table 3. PCIe SAS RAID controller cards

CCIN (custom card identification number)	57BA	57C7	57CB	57CC	57CD	57CF
Description	PCIe x8 Ext Dual-x4 3 Gb SAS Adapter and Cable Card	PCI Express x8 Planar 3 Gb SAS Adapter (Disk/Media Backplane)	PCIe x4 Planar 3 Gb SAS RAID Adapter	PCIe x8 Internal 3 Gb SAS Adapter	PCIe SAS RAID and SSD Adapter 3 Gb x8	PCI Express x8 Planar 3 Gb SAS RAID Adapter (with 175 MB Cache RAID - Dual IOA Enablement Card)

Table 3. PCIe SAS RAID controller cards (continued)

CCIN (custom card identification number)	57BA	57C7	57CB	57CC	57CD	57CF
Form factor	Combination PCIe x8 and Cable Card	Planar	Planar cache enablement	PCIe unique to IBM PureSystems™	Double Wide PCIe x8 with 1 - 4 integrated SSDs	Planar and Enablement Card
Adapter failing function code LED value	2D0B	2D14	2D26	2D29	2D40	2D15
Physical links	8 (two mini SAS 4x connectors, one required to connect by an external AI cable to the top mini-SAS 4x Cable Card connector)	8	8 (two 2x wide ports to shared SAS drives and one 2x wide port to 2B4F, one physical link to DVD, and optionally one physical link to tape drive)	1	4 (one direct SAS physical link to each integrated SSD)	8
RAID levels supported	RAID 0, 5[1], 6[1], 10	RAID 0, 5[1], 6[1], 10	RAID 0, 5, 6, 10	RAID 0	RAID 0[2], 5	RAID 0, 5, 6, 10
Adding disks to an existing disk array supported RAID levels	RAID 5, 6	RAID 5, 6	RAID 5, 6		RAID 5, 6	RAID 5, 6
Write cache size[4]			175 MB			175 MB
Read cache size						
Cache battery pack technology			LiIon			LiIon
Cache battery pack FFC			2D1B			2D19
Cache battery concurrent maintenance	No	No	No	No	No	Yes
Cache data present LED	No	No	Yes	No	No	Yes
Removable cache card	No	No	No	No	No	No
Auxiliary write cache (AWC) support	No	No	No	No	No	No
High availability (HA) two system RAID	No	No	Yes	No	No	Yes
HA two system JBOD	No	No	No	No	No	No
HA single system RAID	No	No	Yes	No	No	Yes
Requires HA RAID configuration	No	No	Yes	No	No	Yes
JBOD support	Yes	Yes	No	Yes	Yes[3]	No

[1] The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6 or use solid-state drives (SSDs) where supported to improve write performance.

[2] RAID 0 requires the use of AIX logical value manager (LVM) mirroring.

[3] The integrated SSDs are allowed to run in JBOD mode.

[4] Nonvolatile write cache is supported only for RAID disk arrays.

Figure 8. CCIN 574E PCIe x8 Ext Dual-x4 3 Gb SAS RAID adapter (disk/media backplane)
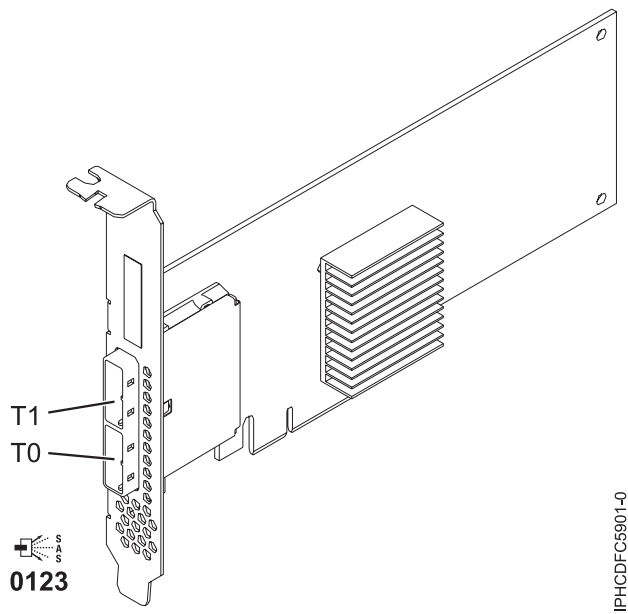
Figure 9. CCIN 57B3 PCIe x8 Ext Dual-x4 3 Gb SAS adapter
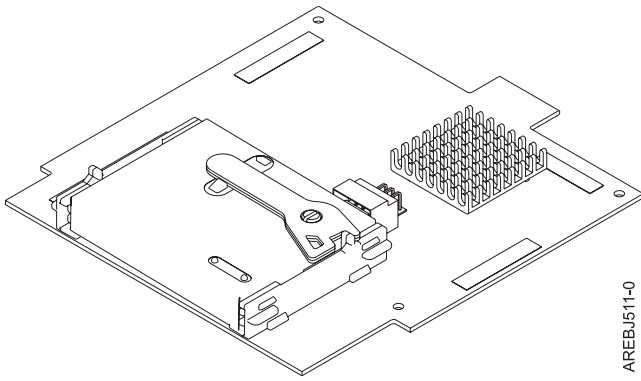
Figure 10. CCIN 57B7 Planar auxiliary cache
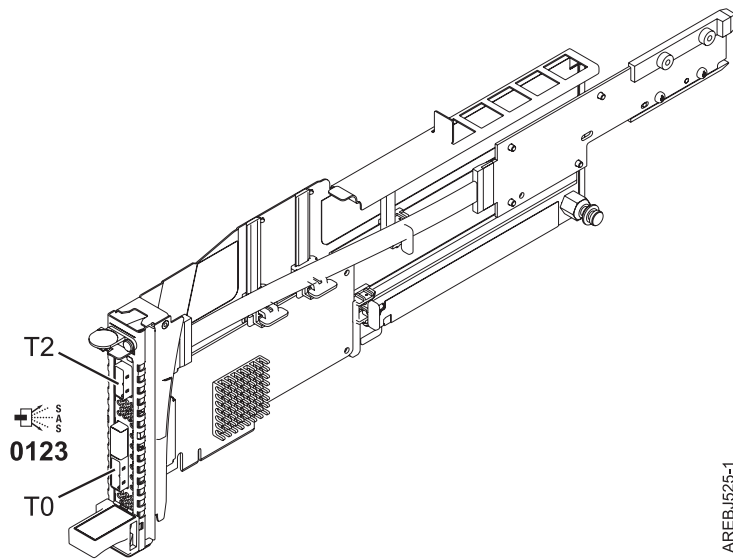
Figure 11. CCIN 57B9 PCIe x8 Ext Dual-x4 3 Gb SAS adapter and cable card
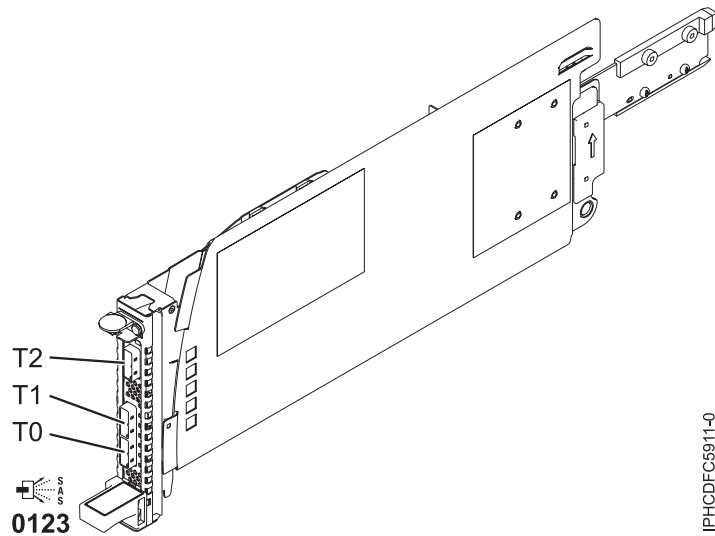
Figure 12. CCIN 57BA PCIe x8 Ext Dual-x4 3 Gb SAS adapter and cable card
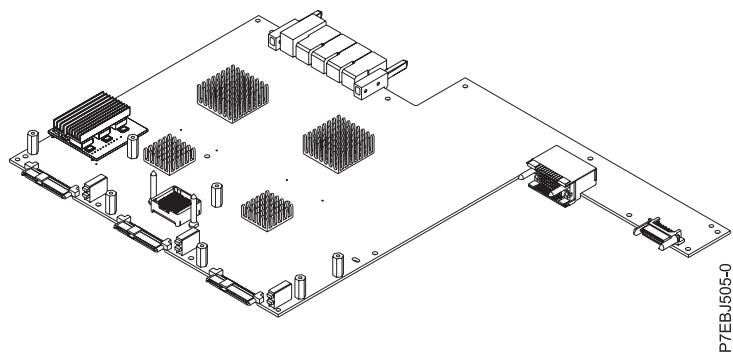
Figure 13. CCIN 57C7 PCI Express x8 Planar 3 Gb SAS adapter (with 175 MB Cache RAID - Dual IOA Enablement card)
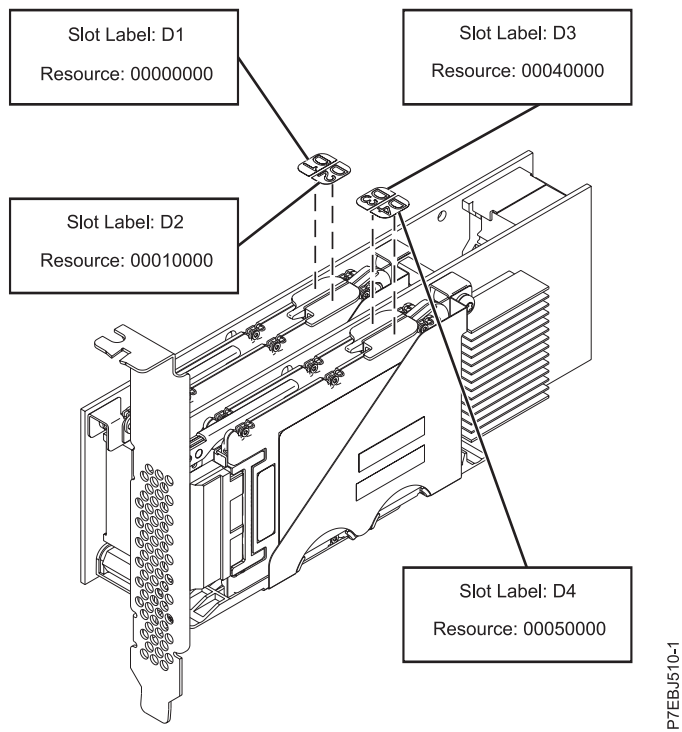
Figure 14. CCIN 57CD PCIe SAS RAID and 3 Gb x8 SSD adapter
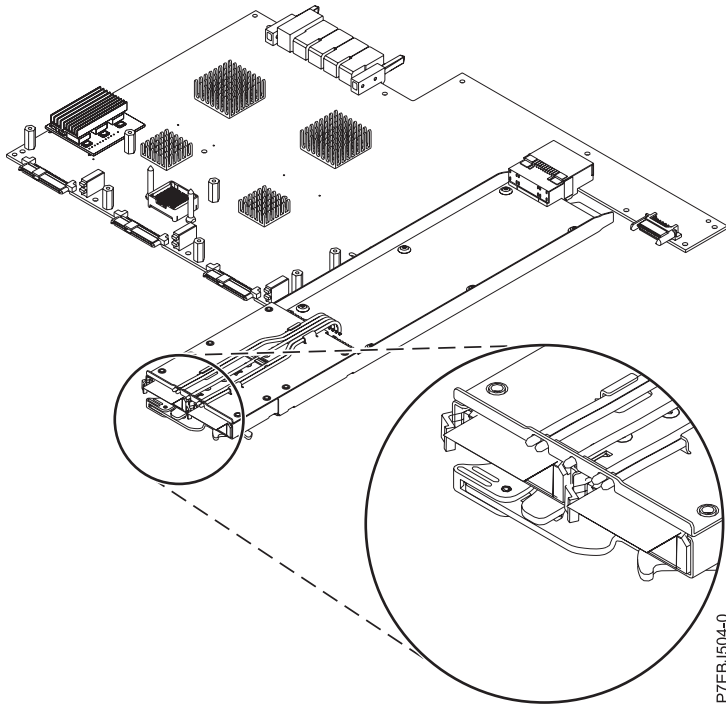
Figure 15. CCIN 57CF PCI Express x8 Planar 3 Gb SAS RAID adapter (with 175 MB Cache RAID - Dual IOA Enablement card)

Planar RAID/Cache Storage Controller
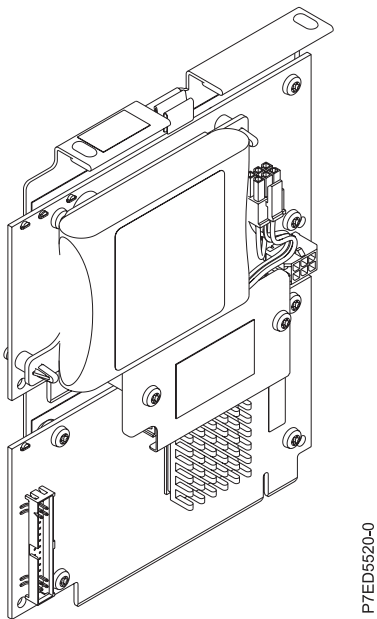
Figure 16. CCIN 2B4C PCIe x4 internal 3 Gb SAS adapter

Planar RAID 10 Storage Controller
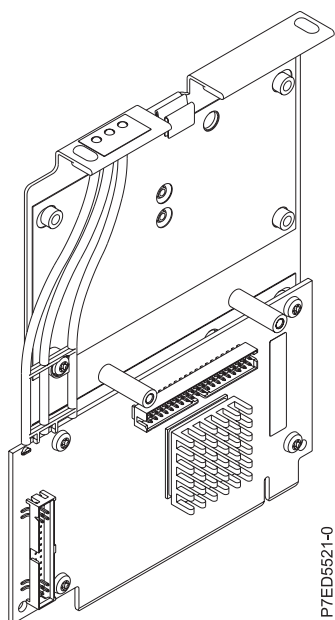
Figure 17. CCIN 2B4F PCIe x4 internal 3Gb SAS RAID adapter

PCIe2 SAS RAID card comparison

This table compares the main features of PCI Express® 2.0 (PCIe2) SAS RAID cards.

Table 4. PCIe2 SAS RAID controller cards

CCIN (custom card identification number)	57B5[1]	57C4[2]	57C3
Description	PCIe2 1.8 GB Cache RAID SAS adapter Tri-port 6 Gb	PCIe2 RAID SAS Adapter Dual-port 6 Gb	PCIe2 3.1GB Cache RAID SAS Enclosure 6Gb x8
Form factor	PCIe2 x8	PCIe2 x8	PCIe2 x8 Storage Enclosure
Adapter failing function code LED value	2D20	2D1D	2D24
Physical links	11 (three mini SAS HD 4x connectors with top connector containing three physical links)	8 (two mini SAS HD 4x connectors)	11 internally integrated with two external mini SAS HD 4x connectors, each containing three physical links
RAID levels supported	RAID 0, 5, 6, 10	RAID 0, 5, 6, 10	RAID 0, 5, 6, 10
Adding disks to an existing disk array supported RAID levels			
Write cache size	1.8 GB		3.1 GB
Read cache size			
Cache battery pack technology	None (uses supercapacitor technology)		None (uses supercapacitor technology)
Cache battery pack FFC			
Cache battery concurrent maintenance			
Cache data present LED			
Removable cache card			
Auxiliary write cache (AWC) support	No	No	No
High availability (HA) two-system RAID	Yes	Yes	Yes
HA two-system JBOD	No	No	No

Table 4. PCIe2 SAS RAID controller cards (continued)

CCIN (custom card identification number)	57B5[1]	57C4[2]	57C3
HA single-system RAID	Yes	Yes	Yes
Requires HA RAID configuration	Yes	No	Yes
JBOD support	No	No	No

Notes:

1. Feature 5913 (CCIN 57B5) adapters installed in POWER6 servers must be placed in I/O expansion units. Feature 5913 (CCIN 57B5) adapters are not supported in POWER6 system units. Feature 5913 (CCIN 57B5) is supported for the full set of SAS adapter functions on POWER6 servers with the exception of controlling boot drives or load source drives.

2. Feature ESA1 or ESA2 (CCIN 57C4) only supports connecting to SSD devices.
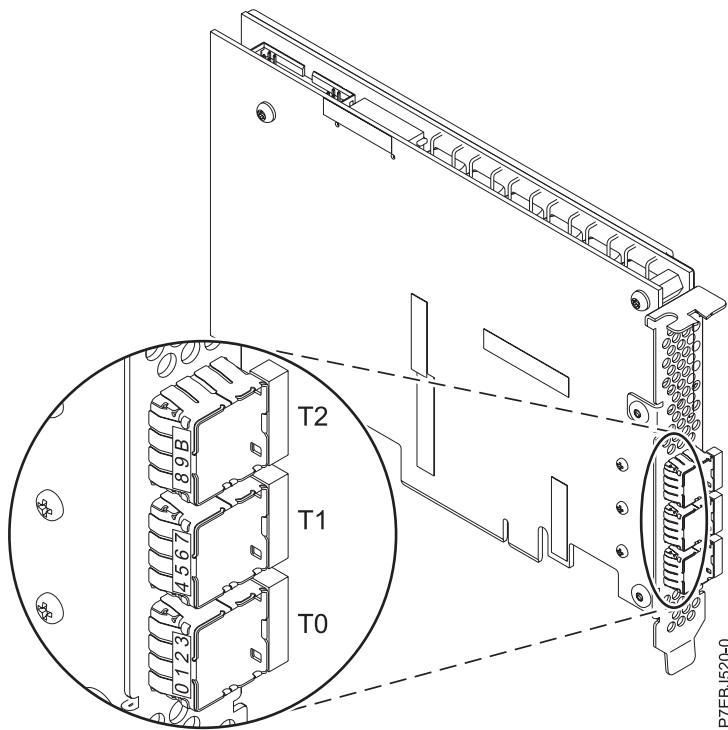
Figure 18. CCIN 57B5 PCIe2 1.8 GB cache RAID SAS adapter Tri-port 6 Gb
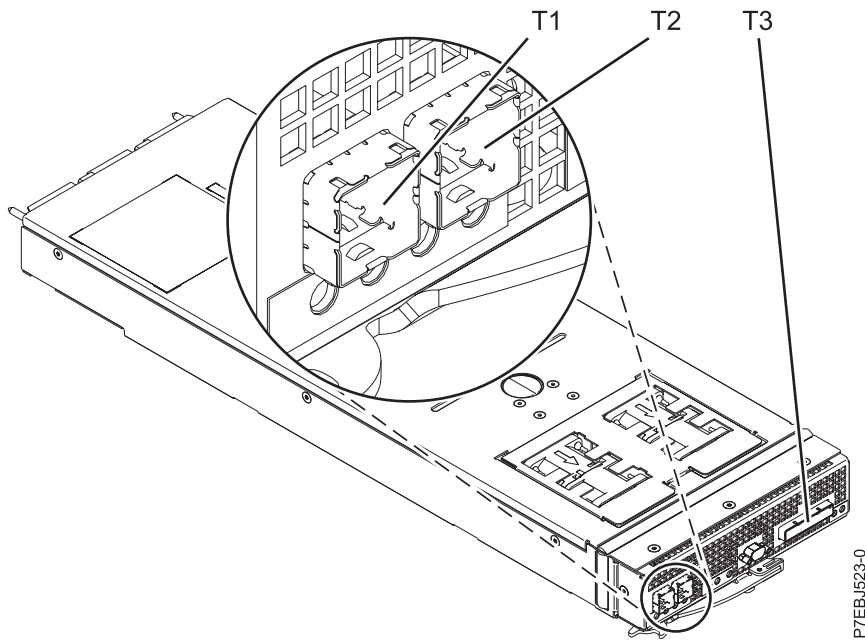
Figure 19. CCIN 57C3 PCIe2 3.1 GB Cache RAID SAS Enclosure 6 Gb x8
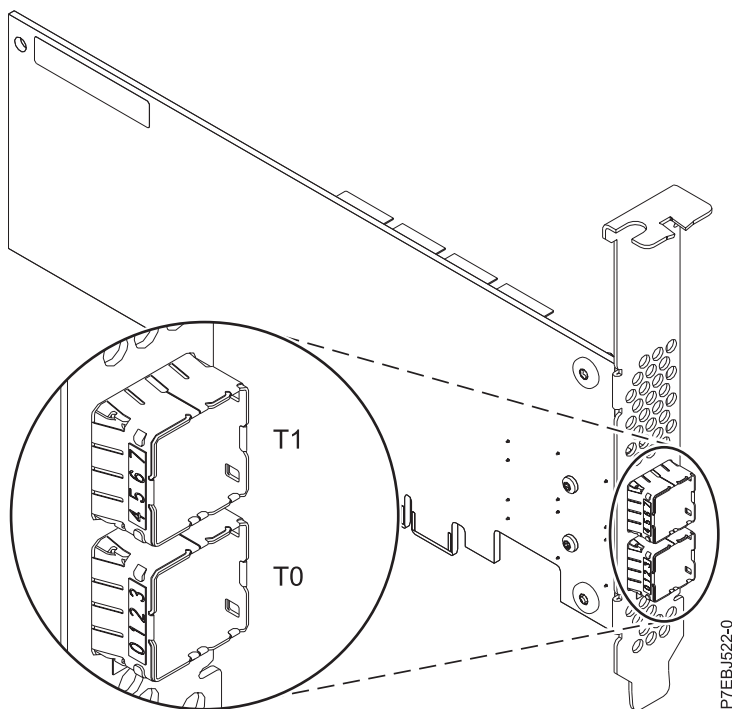
Figure 20. CCIN 57C4 PCIe2 RAID SAS Adapter Dual-port 6 Gb

SAS architecture

Serial-attached SCSI (SAS) architecture describes a serial device interconnection and transportation protocol that defines the rules for information exchange between devices.

SAS is an evolution of the parallel SCSI device interface into a serial point-to-point interface. *SAS physical links* are a set of four wires used as two differential signal pairs. One differential signal transmits in one

direction, while the other differential signal transmits in the opposite direction. Data can be transmitted in both directions simultaneously. Physical links are contained in SAS ports, which contain one or more physical links. A port is a wide port if there are more than one physical link in the port. If there is only one physical link in the port, it is a narrow port. A port is identified by a unique SAS worldwide name (also called SAS address).

An SAS controller contains one or more SAS ports. A *path* is a logical point-to-point link between a SAS initiator port in the controller and a SAS target port in the I/O device (for example, a disk). A *connection* is a temporary association between a controller and an I/O device through a path. A connection enables communication to a device. The controller can communicate to the I/O device over this connection by using either the SCSI command set or the Advanced Technology Attachment (ATA) and Advanced technology Attachment Packet Interface (ATAPI) command set depending on the device type.

An SAS expander enables connections between a controller port and multiple I/O device ports by routing connections between the expander ports. Only a single connection through an expander can exist at any given time. Using expanders creates more nodes in the path from the controller to the I/O device. If an I/O device supports multiple ports, more than one path to the device can exist when there are expander devices included in the path.

An *SAS fabric* refers to the summation of all paths between all SAS controller ports and all I/O device ports in the SAS subsystem including cables, enclosures, and expanders.

The following example SAS subsystem shows some of the concepts described in this SAS overview. A controller is shown with eight SAS physical links. Four of those physical links are connected into two different wide ports. One connector contains four physical links grouped into two ports. The connectors have no significance in SAS other than causing a physical wire connection. The four-physical links connector can contain one to four ports depending on the type of cabling that is used. The uppermost port in the figure shows a controller-wide port number 6 that consists of physical link numbers 6 and 7. Port 6 connects to an expander, which attaches to one of the dual ports of the I/O devices. The dashed red line indicates a path between the controller and an I/O device. Another path runs from the controller's port number 4 to the other port of the I/O device. These two paths provide two different connections for increased reliability by using redundant controller ports, expanders, and I/O device ports. The SCSI Enclosure Services (SES) is a component of each expander.
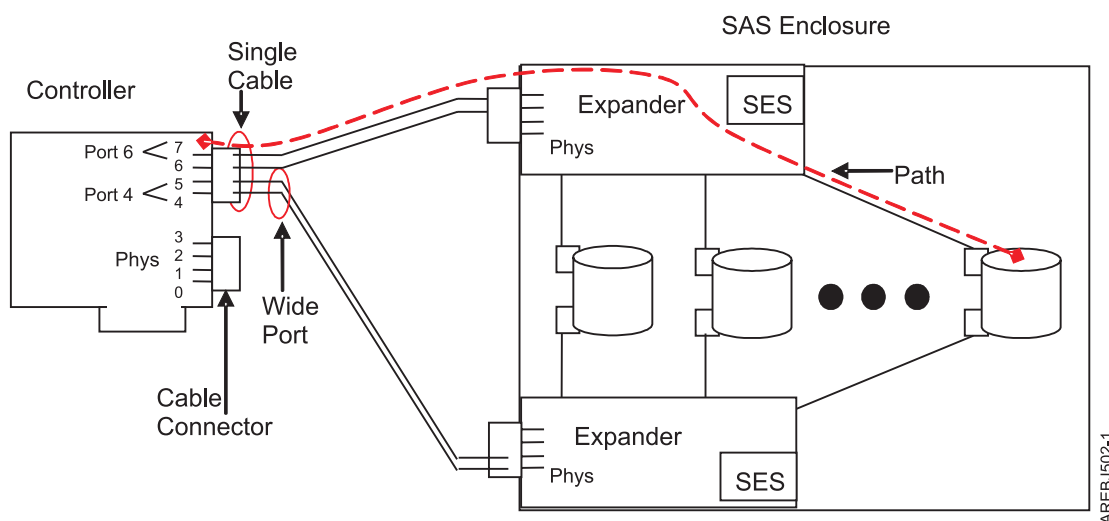
Figure 21. Example SAS subsystem

Disk arrays

Disk arrays are groups of disks that work together with a specialized array controller to take advantage of potentially higher data transfer rates and, depending on the RAID level selected, data redundancy.

Disk arrays use RAID technology to offer data redundancy and improved data transfer rates over those provided by single large disks. If a disk failure occurs, the disk can usually be replaced without interrupting normal system operation.

Data redundancy

The disk array controller keeps track of how the data is distributed across the disks. RAID 5, 6, and 10 disk arrays also provide data redundancy, so that no data is lost if a single disk in the array fails. If a disk failure occurs, the disk can usually be replaced without interrupting normal system operation.

Using arrays

Each disk array can be used by AIX in the same way as it would a single non-RAID disk. For example, after creating a disk array, you can create a file system on the disk array or use AIX commands to make the disk array available to the system by adding the disk array to a volume group.

hdisk

Like other disk storage units in AIX, the disk arrays are assigned names using the hdisk form. The names are deleted when you delete the disk array. An *hdisk* is a disk that is formatted to 512 bytes per sector. These disks must be formatted to 528 bytes per sector before they can be used in disk arrays.

pdisk

The individual physical disks that comprise disk arrays (or serve as candidates to be used in disk arrays) are represented by pdisk names. A *pdisk* is a disk that is formatted to 528 bytes per sector.

Array management

The IBM SAS RAID controller is managed by the IBM SAS Disk Array Manager. The disk array manager serves as the interface to the controller and I/O device configuration. It is also responsible for the monitoring and recovery features of the controller.

Boot device

If a disk array is to be used as the boot device, you might have to prepare the disks by booting from the IBM server hardware stand-alone diagnostics CD and creating the disk array before installing AIX. You might want to perform this procedure when the original boot drive is to be used as part of a disk array.

Array configuration

The following figure illustrates a possible disk array configuration.
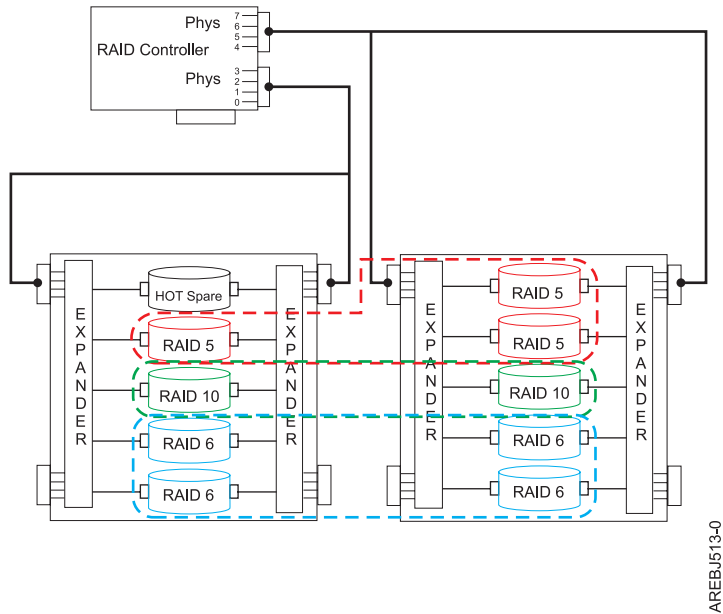
Figure 22. Disk array configuration

The **List SAS Disk Array Configuration** option in the disk array manager can be used to display the pdisk and hdisk names, their associated location codes, and their current state of operation. The following sample output is displayed when the **List SAS Disk Array Configuration** option is invoked.

```
+------------------------------------------------------------------------------+
|                                                                              |
|     --------------------------------------------------------------------     |
|     Name      Resource  State      Description           Size                |
|     --------------------------------------------------------------------     |
|     sissas0   FFFFFFFF  Primary    PCI-X266 Planar 3 Gb SAS Adapter          |
|                                                                              |
|     hdisk8    00FF0100  Optimal    RAID 6 Array            69.6GB            |
|       pdisk0  00040100  Active     Array Member            34.8GB            |
|       pdisk2  00040B00  Active     Array Member            34.8GB            |
|       pdisk8  00000500  Active     Array Member            34.8GB            |
|       pdisk9  00000A00  Active     Array Member            34.8GB            |
|                                                                              |
|     hdisk7    00FF0000  Optimal    RAID 0 Array            34.8GB            |
|       pdisk4  00040000  Active     Array Member            34.8GB            |
|                                                                              |
|     hdisk13   00FF0300  Optimal    RAID 0 Array            34.8GB            |
|       pdisk5  00040300  Active     Array Member            34.8GB            |
|                                                                              |
|     hdisk14   00FF0400  Failed     RAID 0 Array            34.8GB            |
|       pdisk3  00040A00  Failed     Array Member            34.8GB            |
|                                                                              |
|     hdisk0    00040500  Available  SAS Disk Drive         146.8GB            |
|     hdisk1    00040600  Available  SAS Disk Drive         146.8GB            |
|     hdisk3    00000600  Available  SAS Disk Drive          73.4GB            |
+------------------------------------------------------------------------------+
```

Related tasks:

"Preparing disks for use in SAS disk arrays" on page 35
Use this information to prepare disks for use in an array.

"Viewing the disk array configuration" on page 38
Use this procedure to view SAS disk array configurations on your server.

Supported RAID levels

The RAID level of a disk array determines how data is stored on the disk array and the level of protection that is provided.

If a part of the RAID system fails, different RAID levels help to recover lost data in different ways. With the exception of RAID level 0, if a single drive fails within an array, the array controller can reconstruct the data for the Failed disk by using the data stored on other hard drives within the array. This data reconstruction has little or no impact to current system programs and users. The controller supports RAID levels 0, 5, 6, and 10. Not all controllers support all RAID levels. Each RAID level supported by the controller has its own attributes and uses a different method of writing data. The following information provides details for each supported RAID level.

Related concepts:

"PCI-X SAS RAID card comparison" on page 4
This table compares the main features of PCI-X SAS RAID cards.

"PCIe SAS RAID card comparison" on page 9
Use the tables provided here to compare the main features of PCI Express (PCIe) SAS RAID cards.

RAID 0

Learn how data is written to a RAID 0 array.

RAID 0 stripes data across the disks in the array, for optimal performance. For a RAID 0 array of three disks, data would be written in the following pattern.
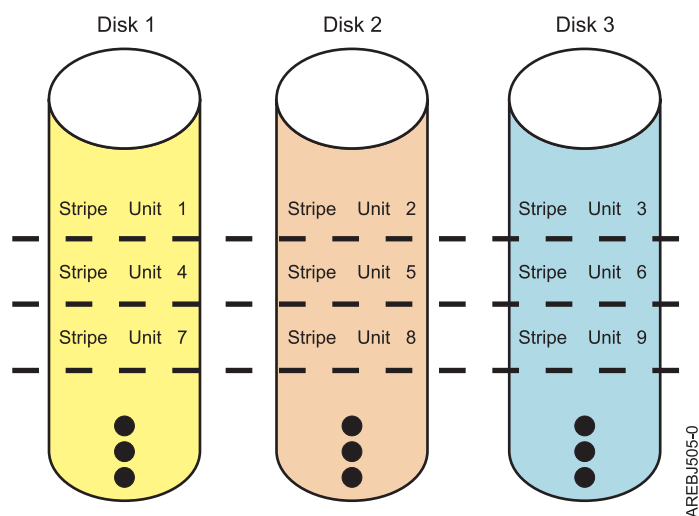
Figure 23. RAID 0

RAID 0 offers a high potential I/O rate, but it is a nonredundant configuration. As a result, there is no data redundancy available for the purpose of reconstructing data in the event of a disk failure. There is no error recovery beyond what is normally provided on a single disk. Unlike other RAID levels, the array

controller never marks a RAID 0 array as Degraded as the result of a disk failure. If a physical disk fails in a RAID 0 disk array, the disk array is marked as Failed. All data in the array must be backed up regularly to protect against data loss.

RAID 5

Learn how data is written to a RAID 5 array.

RAID 5 stripes data across all disks in the array. RAID level 5 also writes array parity data. The parity data is spread across all the disks. For a RAID 5 array of three disks, array data and parity information is written in the following pattern:
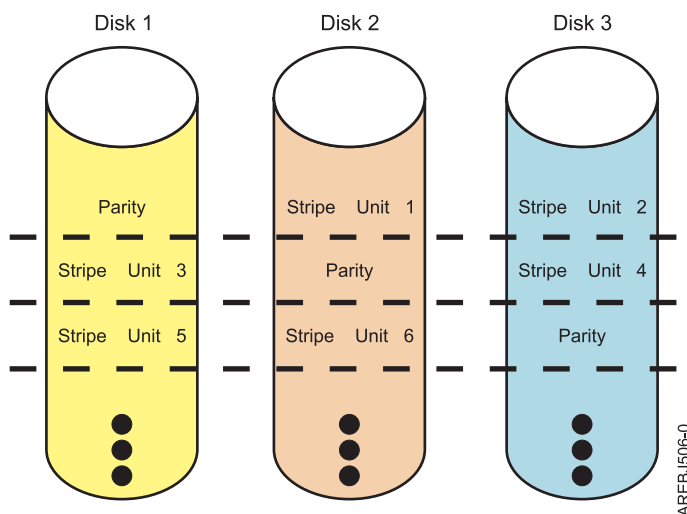
Figure 24. RAID 5

If a disk fails in a RAID 5 array, you can continue to use the array normally. A RAID 5 array that is operating with a single failed disk is said to be operating in degraded mode. Whenever data is read from a degraded disk array, the array controller recalculates the data on the failed disk by using data and parity blocks on the operational disks. If a second disk fails, the array is placed in the failed state and is not be accessible.

Related concepts:

"Stripe-unit size" on page 25
With RAID technology, data is striped across an array of physical disks. This data distribution scheme complements the way that the operating system requests data.

RAID 6

Learn how data is written to a RAID 6 array.

RAID 6 stripes data across all disks in the array. RAID level 6 also writes array P and Q parity data. The P and Q parity data, is spread across all the disks. For a RAID 6 array of four disks, array data and parity information is written in the following pattern:
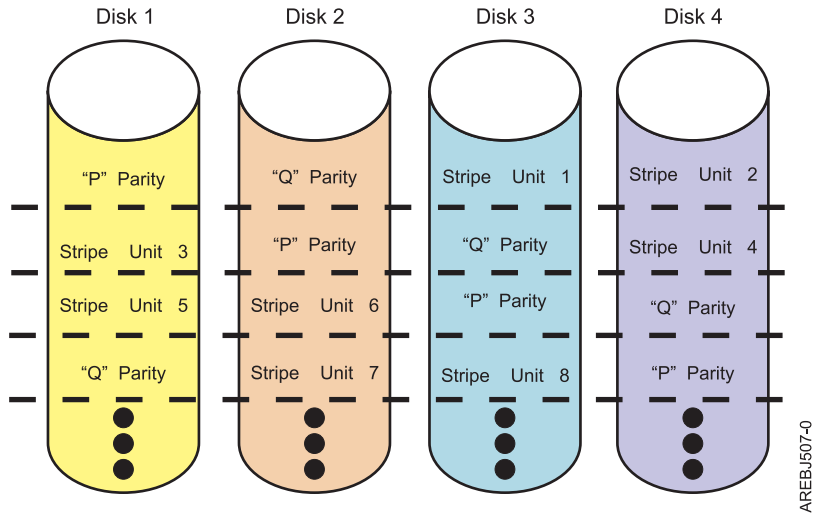
Figure 25. RAID 6

If one or two disks fail in a RAID 6 array, you can continue to use the array normally. A RAID 6 array that is operating with a one or two failed disks is said to be operating in degraded mode. Whenever data is read from a degraded disk array, the array controller recalculates the data on the failed disks by using data and parity blocks on the operational disks. A RAID 6 array with a single failed disk has similar protection to that of a RAID 5 array with no disk failures. If a third disk fails, the array is placed in the failed state and is not be accessible.

RAID 10

Learn how data is written to a RAID 10 array.

RAID 10 uses mirrored pairs to redundantly store data. The array must contain an even number of disks. Two is the minimum number of disks needed to create a RAID 10 array. The data is striped across the mirrored pairs. For example, a RAID 10 array of four disks would have data written to it in the following pattern:
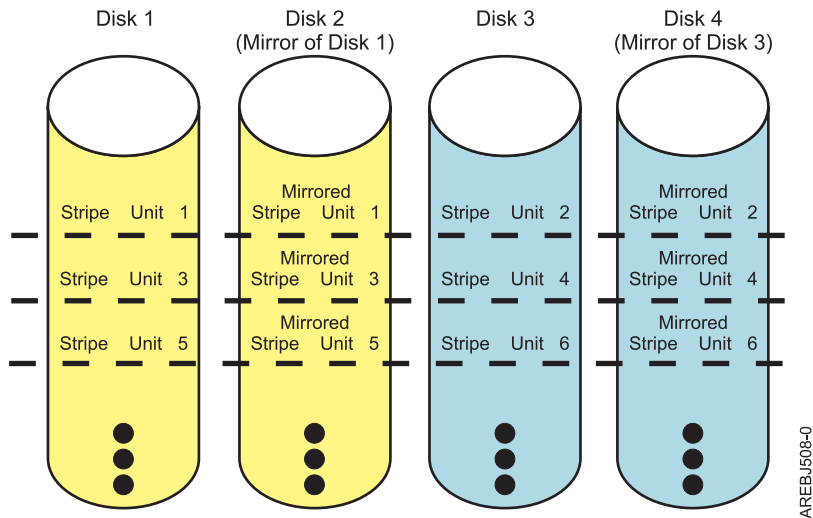
Figure 26. RAID 10

RAID 10 tolerates multiple disk failures. If one disk in each mirrored pair fails, the array will still be functional, operating in Degraded mode. You can continue to use the array normally because for each Failed disk, the data is stored redundantly on its mirrored pair. However, if both members of a mirrored pair fail, the array will be placed in the Failed state and will not be accessible.

When a RAID 10 disk array is created, the controller will automatically attempt to select the disks for each mirrored pair from a different controller connector (a different cable to a different device enclosure). For example, if four disks selected for the disk array are located on one of the controller's connectors and another four disks selected are located on another of the controller's connectors, the controller will automatically attempt to create each mirrored pair from one disk on each controller connector. In the event of a controller port, cable, or enclosure failure, each mirrored pair will continue to operate in a Degraded mode. Such redundancy requires careful planning when you are determining where to place devices.

Disk array capacities

These guidelines will help you calculate the capacity of a disk array.

The capacity of a disk array depends on the capacity of the disks used and the RAID level of the array. To calculate the capacity of a disk array, do the following:

RAID 0
> Multiply the number of disks by the disk capacity.

RAID 5
> Multiply one fewer than the number of disks by the disk capacity.

RAID 6
> Multiply two fewer than the number of disks by the disk capacity.

RAID 10
> Multiply the number of disks by the disk capacity and divide by 2.

Note: If disks of different capacities are used in the same array, all disks are treated as if they have the capacity of the smallest disk.

RAID level summary

Compare RAID levels according to their capabilities.

The following information provides data redundancy, usable disk capacity, read performance, and write performance for each RAID level.

Table 5. RAID level summary

RAID level	Data redundancy	Usable disk capacity	Read performance	Write performance	Min/Max devices per array on PCI-X and PCIe controllers	Min/Max devices per array on PCIe2 controllers
RAID 0	None	100%	Very good	Excellent	1/18	1/32
RAID 5	Very good	67% to 94%	Very good	Good	3/18	3/32
RAID 6	Excellent	50% to 89%	Very good	Fair to good	4/18	4/32
RAID 10	Excellent	50%	Excellent	Very good	2/18 (even numbers only)	2/32 (even numbers only)

RAID 0
> Does not support data redundancy, but provides a potentially higher I/O rate.

RAID 5
> Creates array parity information so that the data can be reconstructed if a disk in the array fails. Provides better capacity than RAID level 10 but possibly lower performance.

RAID 6

Creates array "P" and "Q" parity information so that the data can be reconstructed if one or two disks in the array fail. Provides better data redundancy than RAID 5 but with slightly lower capacity and possibly lower performance. Provides better capacity than RAID level 10 but possibly lower performance.

RAID 10

Stores data redundantly on mirrored pairs to provide maximum protection against disk failures. Provides generally better performance than RAID 5 or 6, but has lower capacity.

Note: A two-drive RAID level 10 array is equivalent to RAID level 1.

Stripe-unit size

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

The granularity at which data is stored on one disk of the array before subsequent data is stored on the next disk of the array is called the stripe-unit size. The collection of stripe units, from the first disk of the array to the last disk of the array, is called a stripe.

For PCI-X and PCIe controllers, you can set the stripe-unit size of an IBM SAS Disk Array to 16 KB, 64 KB, 256 KB, or 512 KB. You might be able to maximize the performance of your disk array by setting the stripe-unit size to a value that is slightly larger than the size of the average system I/O request. For large system I/O requests, use a stripe-unit size of 256 KB or 512KB. The recommended stripe size will be identified on the screen when you create the disk array.

For PCIe2 controllers, you can only set a stripe-unit size of 256 KB. This stripe-unit size has been selected to provide the optimum performance when used with both HDDs and SSDs.

Valid states for hdisks and pdisks

Disk arrays and physical disks have several operational states.

States for disk arrays (hdisks)

There are six valid states for disk arrays.

The valid states for IBM SAS Disk Arrays are Optimal, Degraded, Rebuilding, Failed, Missing, and Unknown.

Optimal

The array is functional and fully protected (RAID 5, 6, and 10) with all array member pdisks in the Active state.

Degraded

The array's protection against disk failures is degraded or its performance is degraded. When one or more array member pdisks are in the Failed state, the array is still functional but might no longer be fully protected against disk failures. When all array member pdisks are in the Active state, the array is not performing optimally because of a problem with the controller's nonvolatile write cache.

Rebuilding

Redundancy data for the array is being reconstructed. After the rebuild process has completed, the array will return to the Optimal state. Until then, the array is not fully protected against disk failures.

Failed The array is no longer accessible because of disk failures or configuration problems.

Missing

A previously configured disk array no longer exists.

Unknown

The state of the disk array could not be determined.

States for physical disks (pdisks)

There are five valid states for physical disks.

The valid states for pdisks are Active, RWProtected, Failed, Missing, and Unknown.

Active

The disk is functioning correctly.

RWProtected

The disk is unavailable because of a hardware or a configuration problem.

Failed The controller cannot communicate with the disk, or the pdisk is the cause of the disk array being in a Degraded state.

Missing

The disk was previously connected to the controller but is no longer detected.

Unknown

The state of the disk could not be determined.

pdisk descriptions

The pdisk description indicates whether the disk is configured as an Array Member, Hot Spare, or an Array Candidate.

For an array, the description column of the **List SAS Disk Array Configuration** screen indicates the RAID level of the array. The description column for a pdisk indicates whether the disk is configured as an Array Member, Hot Spare, or an Array Candidate.

Array Member

A 528 bytes per sector pdisk that is configured as a member of an array.

Hot Spare

A 528 bytes per sector pdisk that can be used by the controller to automatically replace a Failed disk in a Degraded RAID 5, 6, or 10 disk array. A Hot Spare disk is useful only if its capacity is greater than or equal to the capacity of the smallest disk in an array that becomes Degraded. For more information about hot spare disks, see "Using hot spare disks" on page 41.

Array Candidate

A 528 bytes per sector pdisk that is a candidate for becoming an Array Member or a Hot Spare.

Auxiliary write cache

A duplicate, nonvolatile copy of write cache data can be preserved.

Auxiliary write cache adapter

The Auxiliary Write Cache (AWC) adapter provides a duplicate, nonvolatile copy of write cache data of the RAID controller to which it is connected.

Protection of data is enhanced by having two battery-backed (nonvolatile) copies of write cache, each stored on separate adapters. If a failure occurs to the write cache portion of the RAID controller, or the RAID controller itself fails in such a way that the write cache data is not recoverable, the AWC adapter provides a backup copy of the write cache data to prevent data loss during the recovery of the failed RAID controller. The cache data is recovered to the new replacement RAID controller and then written out to disk before resuming normal operations.

The AWC adapter is not a failover device that can keep the system operational by continuing disk operations when the attached RAID controller fails. The system cannot use the auxiliary copy of the cache for runtime operations even if only the cache on the RAID controller fails. The AWC adapter does

not support any other device attachment and performs no other tasks than communicating with the attached RAID controller to receive backup write cache data. The purpose of the AWC adapter is to minimize the length of an unplanned outage, due to a failure of a RAID controller, by preventing loss of critical data that might have otherwise required a system reload.

It is important to understand the difference between multi-initiator connections and AWC connections. Connecting controllers in a multi-initiator environment refers to multiple RAID controllers connected to a common set of disk enclosures and disks. The AWC controller is not connected to the disks, and it does not perform device media accesses.

Important: If a failure of either the RAID controller or the Auxiliary Cache occurs, the Maintenance Analysis Procedures (MAPs) for the service request numbers (SRNs) in the AIX error log must be followed precisely.

The RAID controller and the AWC adapter each require a PCI bus connection and are required to be in the same partition. The two adapters are connected by an internal SAS connection. For the Planar RAID Enablement and Planar Auxiliary Cache features, the dedicated SAS connection is integrated into the system planar.

If the AWC adapter itself fails or the SAS link between the two adapters fails, the RAID controller will stop caching operations, destage existing write cache data to disk, and run in a performance-degraded mode. After the AWC adapter is replaced or the link is reestablished, the RAID controller automatically recognizes the AWC, synchronizes the cache area, resumes normal caching function, and resumes writing the duplicate cache data to the AWC.

The AWC adapter is typically used in conjunction with RAID protection. RAID functions are not affected by the attachment of an AWC. Because the AWC does not control other devices over the bus and communicates directly with its attached RAID controller over a dedicated SAS bus, it has little, if any, performance impact on the system.
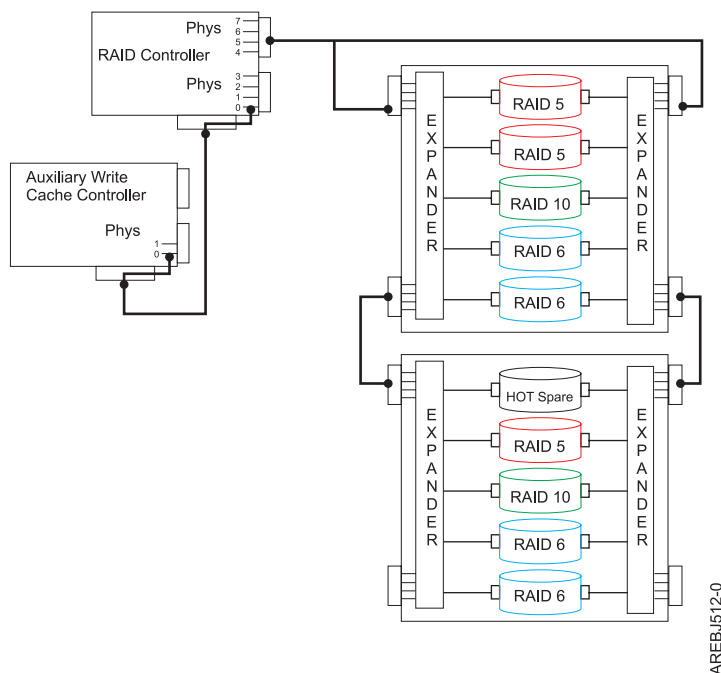
Figure 27. Example RAID and AWC controller configuration

Related concepts:

"Multi-initiator and high availability" on page 55
You can increase availability using multi-initiator and high availability to connect multiple controllers to a common set of disk expansion drawers.

"Problem determination and recovery" on page 107
AIX diagnostics and utilities are used to assist in problem determination and recovery tasks.

Installing the auxiliary write cache

Follow these step-by-step instructions to install the auxiliary write cache.

Note: Disk arrays can be previously configured or new arrays can be created after the auxiliary cache environment configuration is set up.

1. Ensure that both the storage I/O adapter and AWC adapter are installed in the same partition and in the same enclosure.

2. Update to the latest adapter microcode from the code download web site, and to the required levels of both the AIX version and the AIX driver package for your specific adapters. See AIX software requirements for the required code levels, and also refer to the installation information for the adapter.

3. Power on the system or partition and verify the function of adapters and disk arrays. See "Viewing the disk array configuration" on page 38. The output displayed will be similar to the following screen examples.

```
+--------------------------------------------------------------------------------+
|                            COMMAND STATUS                                       |
|                                                                                 |
| Command: OK           stdout: yes           stderr: no                          |
|                                                                                 |
| Before command completion, additional instructions can appear below.            |
|                                                                                 |
|  ------------------------------------------------------------------------        |
| Name      Resource  State       Description               Size                  |
|  ------------------------------------------------------------------------        |
| sissas2   FFFFFFFF  Available   PCIe x1 Auxiliary Cache Adapter                  |
|  sissas1  FFFFFFFF  AWC linked  Redundant cache protected by sissas2            |
|                                                                                 |
|                                                                                 |
|                                                                                 |
|                                                                                 |
|                                                                                 |
|                                                                                 |
|                                                                                 |
| F1=Help             F2=Refresh         F3=Cancel          F6=Command            |
| F8=Image            F9=Shell           F10=Exit           /=Find                |
| n=Find Next                                                                      |
+--------------------------------------------------------------------------------+
```

```
+--------------------------------------------------------------------------+
|                          COMMAND STATUS                                  |
|                                                                          |
|  Command: OK            stdout: yes           stderr: no                 |
|                                                                          |
|  Before command completion, additional instructions might appear below.  |
|                                                                          |
|  ----------------------------------------------------------------------  |
|  Name      Resource  State        Description             Size           |
|  ----------------------------------------------------------------------  |
|  sissas1   FFFFFFFF  Primary      PCI-X266 Planar 3 Gb SAS RAID Adapter  |
|   sissas2  FFFFFFFF  AWC linked   Redundant cache protection for sissas1 |
|                                                                          |
|  pdisk2    00044000  Active       Array Candidate      69.7GB Zeroed     |
|  pdisk4    00044100  Active       Array Candidate      69.7GB Zeroed     |
|  pdisk3    00044200  Active       Array Candidate      69.7GB Zeroed     |
|  pdisk5    00044300  Active       Array Candidate      69.7GB Zeroed     |
|  pdisk7    00044400  Active       Array Candidate      139.6GB           |
|  pdisk0    00044500  Active       Array Candidate      139.6GB           |
|  pdisk1    00044600  Active       Array Candidate      139.6GB           |
|                                                                          |
|                                                                          |
|                                                                          |
|  F1=Help          F2=Refresh        F3=Cancel        F6=Command          |
|  F8=Image         F9=Shell          F10=Exit         /=Find              |
|  n=Find Next                                                             |
+--------------------------------------------------------------------------+
```

4. Verify that both adapters indicate they are Available and AWC Linked to the other adapter, and that all arrays indicate Optimal.

Viewing link status information

You can view more detailed link status information in the Change/Show SAS Controller information screen.

1. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Change/Show SAS RAID controller**.
4. Select the IBM SAS RAID or AWC Controller. The screen displayed will look similar to the following screen.

```
+------------------------------------------------------------------------------+
|                          Change/Show SAS Controller                          |
|                                                                              |
| Type or select values in entry fields.                                       |
| Press Enter AFTER making all desired changes.                                |
|                                                                              |
|                                                      [Entry Fields]          |
|   SAS adapter                                        sissas2                  |
|   Description                                        PCIe2 1.8GB Cache RAID>  |
|   Status                                             Available               |
|   Location                                           06-00                   |
|   Maximum Number of Attached Devices                 512                     |
|   Maximum number of COMMANDS to queue to the adapter 100,300,0               |
|   Maximum Data Transfer Window                       0x1000000,0x5000000,0x>  |
|   Operating mode                                     Primary Adapter         |
|   Adapter Cache                                      Default             +    |
|   Preferred HA Dual Initiator Operating mode         No Preference           |
|   Preferred HA Access State Setting                  Preserve            +    |
|   Dual Initiator Configuration                       Default                 |
|   Serial Number                                      YL3126327310            |
|   World Wide ID                                      5005076c0702bf00         |
|   Remote HA Link Operational                         No                      |
|   Remote HA Serial Number                                                    |
|   Remote HA World Wide ID                                                    |
|   Remote AWC Link Operational                                                |
|   Remote AWC Serial Number                                                   |
|   Remote AWC World Wide ID                                                   |
|                                                                              |
| F1=Help            F2=Refresh         F3=Cancel           F4=List            |
| F5=Reset           F6=Command         F7=Edit             F8=Image           |
| F9=Shell           F10=Exit           Enter=Do                               |
+------------------------------------------------------------------------------+
```

Controller software

For the controller to be identified and configured by AIX, the requisite device support software must be installed. The requisite software for the controller is often preinstalled during AIX installation.

It might be necessary to perform operations related to the installation, verification, and maintenance of the AIX device software for the controller.

Software for the controller is packaged in installp format and distributed as part of the base AIX installation media, AIX update media, and through the Web-based Fix Delivery Center for AIX. This information is an overview of the AIX software support required for the controller. For complete information related to the installation and maintenance of AIX, refer to the IBM System p® and AIX Information Center website.

The controller runs onboard microcode. The AIX command lsmcode can be used to determine the level of onboard microcode being used by the controller. Although a version of controller microcode might be distributed along with AIX, this does not necessarily represent the most recent version of microcode available for the controller.

Related tasks:

"Updating the SAS RAID controller microcode" on page 78
Determine if you need to update your SAS RAID controller microcode, then download and install the updates.

Controller software verification

Support for the controller is contained in the AIX package named **devices.common.IBM.sissas**.

Each controller requires an AIX package described by the following table. These device support packages contain multiple filesets, each related to a different aspect of device support.

Attention: Ensure the adapters are updated with the latest microcode from the Microcode downloads as part of the initial installation.

Table 6. AIX software requirements

CCIN (custom card identification number)	AIX Package	Minimum Required AIX Version
572A	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
572B	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
572C	devices.pci.1410bd02	One of the following: • AIX 5L™ Version 5.2 with Technology Level 10 (5200-10) • AIX 5L Version 5.3 with Technology Level 6 (5300-06) or later
572F/575C	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
574E	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57B3	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57B5	devices.pciex.14103D03	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.

Table 6. AIX software requirements (continued)

CCIN (custom card identification number)	AIX Package	Minimum Required AIX Version
57B7	devices.pciex.14103903	One of the following: • AIX Version 6.1 with Technology Level 0 (6100-00) • AIX 5L Version 5.3 with Technology Level 7 (5300-07), or later • AIX 5L Version 5.3 with Technology Level 6 and Service Pack 7 (5300-06-07), or later
57B8	devices.pci.1410bd02	One of the following: • AIX Version 6.1 with Technology Level 0 (6100-00) • AIX 5L Version 5.3 with Technology Level 7 (5300-07), or later • AIX 5L Version 5.3 with Technology Level 6 and Service Pack 7 (5300-06-07), or later
57B9	devices.pciex.14103903	One of the following: • AIX Version 6.1 with Technology Level 1 (6100-01) • AIX 5L Version 5.3 with Technology Level 8 (5300-08), or later
57BA	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57C3	devices.pciex. 14103D03	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57C4	devices.pciex. 14103D03	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57C7	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57CD	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
57CF	devices.pciex.14103903	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
2BE0	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
2BE1	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.
2BD9	devices.pci.1410bd02	See the **PCI adapter information by feature type** topic in Managing PCI adapters for the minimum AIX level requirements.

To verify that the device support package for the controller is installed, type as an example:

```
lslpp -l devices.common.IBM.sissas
```

Output from this command indicates if device support software for the controller is installed, and if so, what the corresponding levels of each fileset are.

If the output indicates that no filesets of this name are installed, you must install the appropriate package so that the controller can be available for use. This software package is available as part of the base AIX installation media, AIX update media, and through the Web-based Fix Delivery Center for AIX.

Over time, it might become necessary to install software updates so that you have the very latest available level of device software support for the controller. Updates to the device support software are packaged, distributed, and installed through the same mechanisms used for other portions of the AIX base operating system. The standard AIX technical support procedures can be used to determine the latest available level of device software support for the controller.

Common controller and disk array management tasks

You can perform various tasks to manage SAS RAID disk arrays.

Use the information in this section to manage your RAID disk arrays.

Using the Disk Array Manager

The Disk Array Manager is the interface for performing various tasks with disk arrays.

The IBM SAS Disk Array Manager can be accessed either through the System Management Interface Tool (SMIT), or for some tasks, the AIX command line. The Disk Array Manager can also be started from AIX diagnostics.

To start the IBM SAS Disk Array Manager, complete the following steps:
1. At the command prompt, type `smit`, and press Enter.
2. Select **Devices**.
3. Select **Disk Array**.
4. Select **IBM SAS Disk Array**.
5. Select **IBM SAS Disk Array Manager** from the menu with options for configuring and managing the IBM SAS RAID Controller.

The following menu for managing disk arrays is displayed.

```
+------------------------------------------------------------------------------+
|                                                                              |
|                          IBM SAS Disk Array Manager                          |
|                                                                              |
|Move cursor to desired item and press Enter.                                  |
|                                                                              |
|  List SAS Disk Array Configuration                                           |
|  Create an Array Candidate pdisk and Format to 528 Byte Sectors              |
|  Create a SAS Disk Array                                                     |
|  Delete a SAS Disk Array                                                     |
|  Add Disks to an Existing SAS Disk Array                                     |
|  Configure a Defined SAS Disk Array                                          |
|  Change/Show Characteristics of a SAS Disk Array                             |
|  Manage HA Access Characteristics of a SAS Disk Array                        |
|  Reconstruct a SAS Disk Array                                                |
|  Change/Show SAS pdisk Status                                                |
|  Diagnostics and Recovery Options                                            |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|F1=Help              F2=Refresh          F3=Cancel           F8=Image         |
|F9=Shell             F10=Exit            Enter=Do                             |
+------------------------------------------------------------------------------+
```

You can also use a SMIT fast path to start the IBM SAS Disk Array Manager. On the AIX command line, type smit sasdam, and press Enter.

If a disk array is to be used as the boot device, you might need to prepare the disks by booting from the IBM server hardware stand-alone diagnostics CD and creating the disk array before installing AIX. You might want to perform this procedure when the original boot drive is to be used as part of a disk array.

To start the IBM SAS Disk Array Manager from the AIX diagnostics, complete the following steps:
1. Start the AIX diagnostics, and on the Function Selection display, select **Task Selection**.
2. Select **RAID Array Manager** and press Enter.
3. Select **IBM SAS Disk Array Manager** and press Enter.

Related concepts:

"AIX command-line interface" on page 51

Many tasks used to manage the SAS RAID controller can be performed by using the AIX command line instead of using the SAS Disk Array Manager.

Preparing disks for use in SAS disk arrays

Use this information to prepare disks for use in an array.

Before a disk can be used in a disk array, it must be a 528 bytes per sector Array Candidate pdisk. To create an Array Candidate pdisk and format it to 528 byte sectors, do the following:

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Create an Array Candidate pdisk and Format to 528 Byte Sectors**.
3. Select the appropriate controller.
4. Select the disks that you want to prepare for use in the SAS disk arrays.

   Attention: Continuing with this option will format the disks. All data on the disks will be lost. Some disks require that their microcode be updated to the latest level before being formatted to 528 byte sectors.

   A message will display asking if you want to continue.

5. To proceed with the format, select **OK** or press Enter to continue. To return to the previous menu without formatting the disks, select **Cancel**.

After the formatting is complete, the disks will be Array Candidate pdisks and will be ready for use in disk arrays. This operation will also zero all the data on the disks. The controller keeps track of the disks that have their data zeroed. These Zeroed Array Candidate pdisks can be used to create a disk array that will be immediately protected against disk failures, and they are the only disks that can be added to an existing disk array. An Array Candidate pdisk will lose its Zeroed state after it has been used in an array or is unconfigured. It will also lose its Zeroed state after the system has been rebooted or the controller has been unconfigured. To return an Array Candidate pdisk to the Zeroed state, follow the steps previously described in this section for preparing disks for use in disk arrays. For more information, see "Disk arrays" on page 19.

Creating a disk array

A disk array is created using a set of Active Array Candidate pdisks.

For disk arrays with data redundancy (RAID 5, 6, and 10), if all of the pdisks are in the Zeroed state, the array will become immediately protected against failures. However, if one or more of the pdisks are not Zeroed, the newly created array will initially be in the Rebuilding state. It will be unprotected against disk failures until parity data on all of the disks has been recalculated. Ensure that all pdisks are placed in a Zeroed state by selecting Create an Array Candidate pdisk and format to 528 Byte Sectors before creating a disk array to fully initialize the pdisks and provide the shortest time to create the disk array.

A disk array must be created with either all HDDs or SSDs. Disk arrays consisting of HDDs and disk arrays consisting of SSDs may coexist on the same controller.

To create a IBM SAS Disk Array, do the following:

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Create a IBM SAS Disk Array**.
3. Select the appropriate IBM SAS RAID Controller on which you want to create an array.

4. Select the RAID level for the array. For more information about selecting an appropriate RAID level, see "Supported RAID levels" on page 21.

5. Select the stripe size in kilobytes for the array. For more information about the stripe-size parameter, see "Stripe-unit size" on page 25.

   A selection screen similar to the following representation displays. It will display a list of Array Candidate pdisks and notes regarding array requirements. The minimum and maximum number of supported disks will be specified, along with any other specific requirements for the array. Select the disks that you want to use in the array according to the requirements on this screen.

```
+-------------------------------------------------------------------------+
|                       Select Disks to Use in the Array                  |
|                                                                         |
|  Move cursor to desired item and press F7. Use arrow keys to scroll.    |
|      ONE OR MORE items can be selected.                                 |
|  Press Enter AFTER making all selections.                               |
|                                                                         |
|     # RAID 5 supports a minimum of 3 and a maximum of 18 drives.        |
|                                                                         |
|                                                                         |
|     pdisk1   00040200  Active      Array Candidate       34.8GB Zeroed  |
|     pdisk3   00040900  Active      Array Candidate       34.8GB Zeroed  |
|     pdisk4   00040000  Active      Array Candidate       34.8GB Zeroed  |
|     pdisk5   00040300  Active      Array Candidate       34.8GB Zeroed  |
|                                                                         |
|   F1=Help              F2=Refresh             F3=Cancel                 |
|   F7=Select            F8=Image               F10=Exit                  |
|   Enter=Do             /=Find                 n=Find Next               |
+-------------------------------------------------------------------------+
```

   A SMIT Dialog Screen summarizes your selections.

6. Press Enter to create the array.

You can now add the disk array to a volume group. Logical volumes and file systems can also be created. Use standard AIX procedures to perform these tasks, and treat the array in the same way that you would treat any hdisk.

Migrating an existing disk array to a new RAID level

The SAS RAID controller supports migrating an existing RAID 0 or 10 disk array to RAID 10 or 0, respectively. This allows you to dynamically change the level of protection of a disk array while preserving its existing data.

When migrating RAID 0 to RAID 10, additional disks must be included into the RAID 10 disk array in order to provide the additional level of protection. The number of additional disks will be equal to the number of disks in the original RAID level 0 disk array. The capacity of the disk array will remain unchanged and the disk array remains accessible during the migration. The disk array is not protected by RAID 10 until the migration completes.

When migrating RAID 10 to RAID 0, no additional disks are included into the RAID 0 disk array. The number of disks in the resulting RAID 0 disk array will be reduced to half the number of disks in the original RAID 10 disk array. The capacity of the disk array will remain unchanged and the disk array remains accessible during the migration.

To migrate an existing array to a new level, do the following:

1. Start the SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.

2. Select **Migrate an Existing SAS Disk Array to a New RAID Level**.

3. Select the SAS disk array which you want to migrate to a new level.

4. Select the desired RAID level from the options shown.

5. Select the desired stripe size from the options shown.
6. Select additional disks to include if necessary to provide the desired level or protection. A screen will display similar to the following:

```
+-----------------------------------------------------------------------------+
|                           IBM SAS Disk Array Manager                        |
|                                                                             |
| Move cursor to desired item and press Enter.                                |
|                                                                             |
|   List SAS Disk Array Configuration                                         |
|   Create an Array Candidate pdisk and Format to 528 Byte Sectors            |
|   Create a SAS Disk Array                                                   |
|   Delete a SAS Disk Array                                                   |
|   Add Disks to an Existing SAS Disk Array                                   |
|   Migrate an Existing SAS Disk Array to a New RAID Level                    |
|     +--------------------------------------------------------------------+  |
|     |            Include Disks during an SAS Disk Array Migration         |  |
|     |                                                                    |  |
|     |   Move cursor to desired item and press F7. Use arrow keys to scroll. |
|     |       ONE OR MORE items can be selected.                           |  |
|     |   Press Enter AFTER making all selections.                         |  |
|     |                                                                    |  |
|     |     # hdisk6 requires 1 additional drives (maximum of 1) for RAID 10. |
|     |                                                                    |  |
|     |     pdisk24   00044000  Active      Array Candidate      139.6GB   |  |
|     |                                                                    |  |
|     |   F1=Help                F2=Refresh              F3=Cancel          |  |
|     |   F7=Select              F8=Image                F10=Exit           |  |
|  F1 |   Enter=Do               /=Find                  n=Find Next        |  |
|  F9 +--------------------------------------------------------------------+  |
+-----------------------------------------------------------------------------+
```

7. Press **Enter** to perform the RAID level migration.

   The migration progress percentage will be displayed next to the array being migrated.

   A screen will display similar to the following.

   Note: If the RAID disk array is in use, the RAID level description might not be updated until after the next IPL.

```
+-----------------------------------------------------------------------------+
|                              COMMAND STATUS                                 |
|                                                                             |
| Command: OK            stdout: yes            stderr: no                    |
|                                                                             |
| Before command completion, additional instructions might appear below.    ||
|                                                                             |
| ------------------------------------------------------------------------    |
| Name       Resource State        Description              Size             |
| ------------------------------------------------------------------------    |
| sissas1    FFFFFFFF Primary      PCI Express x8 Ext Dual-x4 3 Gb SAS RAID Adapter ||
| tmscsi0    00FE0000 HA Linked    Remote adapter SN  081620E4               |
|                                                                             |
| hdisk1     00FF0000 Optimal      RAID 6 Array             139.5GB          |
|  pdisk1    00040400 Active       Array Member             69.7GB           |
|  pdisk2    00040800 Active       Array Member             69.7GB           |
|  pdisk3    00040000 Active       Array Member             69.7GB           |
|  pdisk4    00040100 Active       Array Member             69.7GB           |
|                                                                             |
| hdisk6     00FF0500 Rebuilding   RAID 10 Array            139.6GB Migrate 8% |
|  pdisk12   00040B00 Active       Array Member             139.6GB          |
|  pdisk24   00044000 Active       Array Member             139.6GB          |
|                                                                             |
|                                                                             |
|                                                                             |
| F1=Help            F2=Refresh            F3=Cancel            F6=Command    |
| F8=Image           F9=Shell             F10=Exit             /=Find        |
| n=Find Next                                                                 |
+-----------------------------------------------------------------------------+
```

8. After the RAID level migration is completed, run `cfgmgr` to update the description of the disk array.

Viewing the disk array configuration

Use this procedure to view SAS disk array configurations on your server.

To view the configuration of arrays and disks associated with a particular controller, do the following:
1. Start the Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **List IBM SAS Disk Array Configuration**.
3. Choose one or more controllers.

The output displayed will be similar to the following:

```
+--------------------------------------------------------------------------------+
|                                                                                |
|                              COMMAND STATUS                                     |
|                                                                                |
| Command: OK            stdout: yes            stderr: no                        |
|                                                                                |
| Before command completion, additional instructions might appear below.         |
|                                                                                |
|                                                                                |
| -------------------------------------------------------------------------       |
| Name      Resource  State       Description              Size                   |
| -------------------------------------------------------------------------       |
| sissas0   FFFFFFFF  Primary     PCI-X266 Planar 3 Gb SAS RAID Adapter           |
| sissas1   FEFFFFFF  HA Linked   Remote adapter SN  0001G055                     |
|                                                                                |
| hdisk7    00FF0000  Optimal     RAID 5 Array   (N/N)      69.7GB                |
|  pdisk1   00040200  Active      Array Member             34.8GB                 |
|  pdisk3   00040900  Active      Array Member             34.8GB                 |
|  pdisk4   00040000  Active      Array Member             34.8GB                 |
|                                                                                |
| hdisk8    00FF0100  Rebuilding  RAID 6 Array   (0/N)      69.7GB Rebuild 13%    |
|  pdisk2   00040800  Active      Array Member             34.8GB                 |
|  pdisk7   00040B00  Active      Array Member             34.8GB                 |
|  pdisk9   00000A00  Active      Array Member             34.8GB                 |
|  pdisk11  00000900  Active      Array Member             34.8GB                 |
|                                                                                |
| hdisk12   00FF0200  Optimal     RAID 0 Array   (0/0)      34.8GB                |
|  pdisk5   00040300  Active      Array Member             34.8GB                 |
|                                                                                |
| hdisk4    00FF0400  Rebuilding  RAID 10 Array             69.7GB Create 8%      |
|  pdisk0   00040100  Active      Array Member             69.7GB                 |
|  pdisk6   00040400  Active      Array Member             69.7GB                 |
|                                                                                |
| *unknwn*  00000500  Active      Array Candidate             N/A                 |
| pdisk19   00060A00  Failed      Array Candidate          34.8GB                 |
| pdisk10   00000B00  Active      Array Candidate          34.8GB Zeroed          |
| pdisk17   00000800  RWProtected Array Candidate          69.7GB Format 8%       |
| pdisk18   00000400  Active      Array Candidate          69.7GB Zeroed          |
| pdisk16   00000600  RWProtected Array Candidate          69.7GB Format 7%       |
|                                                                                |
| hdisk0    00040500  Available   SAS Disk Drive          146.8GB                 |
| hdisk1    00040700  Available   SAS Disk Drive          146.8GB                 |
| hdisk2    00040600  Available   SAS Disk Drive          146.8GB                 |
|                                                                                |
| F1=Help           F2=Refresh         F3=Cancel          F6=Command             |
| F8=Image          F9=Shell           F10=Exit           /=Find                 |
| n=Find Next                                                                     |
+--------------------------------------------------------------------------------+
```

The controller's name, location, status, and description are displayed first. Each IBM SAS disk array hdisk is displayed with its Array Member pdisks directly underneath it.
- The first column of output is the name of the disk array (hdisk) or physical disk (pdisk). Note the use of *unknwn* to identify a device known by the controller but not configured in AIX.

- The second column of output is the device's resource location (or simply "Resource"). This value might also be referred to as the device's SCSI ID in other parts of AIX software documentation. For more information on the format of the resource value, see "SAS resource locations" on page 107.
- The third column of the preceding screen is the state of the disk array or pdisk. For information about the possible disk array and pdisk states, see "Disk arrays" on page 19. For 512 byte/sector standalone disks (hdisks), this column is the AIX device state (for example, Available or Defined).
- The fourth column is a description of the device. For a disk array, the description is the RAID level of the array. If the array has HA access optimization configured, an identifier for the current optimization followed by preferred optimization will be shown in parentheses after the raid level, see "HA access characteristics within List SAS Disk Array Configuration" on page 65. For a pdisk, the description can be Array Candidate, Hot Spare, or Array Member.
- The fifth column is the capacity of the array or disk. For information about how the capacity of an array is calculated for each RAID level, see "Disk array capacities" on page 24.
- The sixth column is the status of a long-running command issued to a disk array or pdisk. This column is also used to indicate that an Array Candidate pdisk has had its data zeroed. If there is a long-running command in progress, the percentage complete will be displayed after the command. The following values might be displayed (where nn% is the command percentage complete):

Create nn%
> Disk array is in process of being created.

Delete nn%
> Disk array is in process of being deleted.

Rebuild nn%
> Disk array is in process of being reconstructed.

Resync nn%
> Disk array is in process of having it parity data resynchronized.

Adding nn%
> Disk array is in process of having one or more disks added to it.

Format nn%
> pdisk is in process of being formatted.

Zeroed
> pdisk has been zeroed.

Array Candidate pdisks and Hot Spare pdisks are displayed at the bottom of this screen. The pdisk names are displayed, along with location, state, description, capacity, and long-running command status. Any 512 bytes per sector stand-alone disks (hdisks) are displayed, along with location, state, description, and capacity.

Deleting a disk array

To preserve the data on the disk array, you must first back up all files in the logical volumes and file systems on the disk array before removing the disk array from its volume group.

Attention: After a disk array is deleted, it cannot be accessed. All data will be lost. A disk array that is currently in use or opened cannot be deleted. Also, if a disk array command (such as a disk creation command) is in progress, that disk array cannot be deleted.

To delete the array, do the following:
1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Delete a IBM SAS Disk Array**.
3. Select the IBM SAS RAID Controller.

4. Select the disk array to delete.

When the disk array has been deleted, any Active Array Member pdisks will become Active Array Candidate pdisks.

Adding disks to an existing disk array

Some controllers support adding disks to existing RAID level 5 or 6 disk arrays, which allows you to dynamically increase the capacity of a disk array while preserving its existing data.

After you add disks to an existing disk array, they are protected and become part of the disk array but will not contain parity and the data will not be restriped. Use of this feature, however, will result in a performance penalty. The first part of the performance penalty exists because not all the drives in the array contain parity and therefore the drives with parity are accessed more often for parity updates. The second part of the performance penalty comes from the data not being restriped and therefore reducing the ability to use the hardware assisted stripe write features.

An Array Candidate pdisk is not necessarily a candidate that can be added to an existing array. In addition to being an Array Candidate, the pdisk must also be recognized by the adapter as having its data zeroed. This situation ensures that when the disks are added to the array, the parity data will be correct and the array will remain protected against disk failures.

To add disks to an existing array, do the following:

Note: Not all controllers support adding disks to an existing array. See the feature comparison tables for PCIe2, PCIe and PCI-X cards to look for controllers that contain this support.

1. Ensure that the disks to be added are Zeroed Array Candidate pdisks. For assistance in viewing and changing the state of the disk, see "Preparing disks for use in SAS disk arrays" on page 35 and "Viewing the disk array configuration" on page 38.
2. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
3. Select **Add Disks to an Existing SAS Disk Array**.
4. Select the IBM SAS Disk Array to which you want to add disks.

   A screen will display similar to the following example. If a particular disk is not included in the list, it might not be a candidate that can be added to the array because of the following reasons:

   - The disk's capacity is less than that of the smallest disk already in the array.
   - The disk has not been formatted as a 528 bytes per sector Array Candidate pdisk.
   - The disk does not have its data zeroed.

   For the second and third cases, the disk can be added to an array if it is first formatted using the **Create an Array Candidate pdisk and Format to 528 Byte Sectors** option in the IBM SAS Disk Array Manager.

```
+----------------------------------------------------------------------+
|                  Add Disks to an Existing SAS Disk Array             |
| Move cursor to desired item and press F7. Use arrow keys to scroll.  |
|     ONE OR MORE items can be selected.                               |
| Press Enter AFTER making all selections.                            |
|                                                                      |
|    # Choose up to 14 of the following disks to add to hdisk2        |
|                                                                      |
|   pdisk16   00000600  Active      Array Candidate      69.7GB Zeroed |
|   pdisk17   00000800  Active      Array Candidate      69.7GB Zeroed |
|   pdisk18   00040800  Active      Array Candidate      69.7GB Zeroed |
|                                                                      |
|    # Note: If a disk is not listed here it is either not a candidate |
|    # to be added to this array or it does not have its data zeroed   |
|    # Use the Create an Array Candidate pdisk and Format to 528 Byte  |
|    # Sectors option to format and zero the disk.                    |
|                                                                      |
| F1=Help              F2=Refresh            F3=Cancel                 |
| F7=Select            F8=Image              F10=Exit                  |
| Enter=Do             /=Find                n=Find Next               |
+----------------------------------------------------------------------+
```

5. Press Enter to add the disks to the array.

To enable higher level components in the system to use the increased capacity of the disk array, additional steps might be needed.

Using hot spare disks

Hot spare disks are used to automatically replace a disk that has failed in a redundant RAID environment.

Hot spare disks are useful only if their capacity is greater than or equal to that of the smallest capacity disk in an array that becomes degraded.

Creating hot spare disks

Follow this procedure to create hot spare disks.

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Change/Show SAS pdisk Status**.
3. Select **Create a Hot Spare**.
4. Select the appropriate controller.
5. Select the pdisks that you want to designate as hot spares. A screen summarizes your selections.
6. Press Enter to create the hot spares.

The disk state changes to **Hot Spare**. On subsequent disk failures, reconstruction of failed disks will occur automatically for RAID 5, 6, and 10 disk arrays.

Note: If there is a degraded disk array at the time that a hot spare is configured, reconstruction of the Failed disk begins automatically.

Deleting hot spare disks

Follow this procedure to delete hot spare disks.

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Change/Show SAS pdisk Status**.
3. Select **Delete a Hot Spare**.

4. Select the appropriate controller.
5. Select the hot spares to delete. The hot spares become array candidate pdisks.

Viewing IBM SAS disk array settings

This procedure enables you to view SAS disk array attributes and settings.

To view the settings for a IBM SAS Disk Array, complete the following steps:

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select the **Change/Show Characteristics of a SAS Disk Array** option.
3. Select the desired IBM SAS Disk Array.

A SMIT dialog screen displays the attributes of the selected array. The output displayed will be similar to the following:

```
+--------------------------------------------------------------------------------+
|                 Change/Show Characteristics of a SAS Disk Array                |
|                                                                                |
|Type or select values in entry fields.                                          |
|Press Enter AFTER making all desired changes.                                   |
|                                                                                |
|                                                          [Entry Fields]        |
|   Disk Array                                  hdisk8                           |
|   Description                                 SAS RAID 6 Disk Array            |
|   Status                                      Available                        |
|   Location                                    05-08-00                         |
|   Serial Number                                                                |
|   Physical volume identifier                  none                             |
|   Queue DEPTH                                 16                               |
|   Size in Megabytes                           69797                            |
|   RAID Level                                  6                                |
|   Stripe Size in KB                           256                              |
|                                                                                |
|                                                                                |
|                                                                                |
|                                                                                |
|                                                                                |
|                                                                                |
|F1=Help           F2=Refresh        F3=Cancel           F4=List                 |
|F5=Reset          F6=Command        F7=Edit             F8=Image                |
|F9=Shell          F10=Exit          Enter=Do                                    |
+--------------------------------------------------------------------------------+
```

- The **Physical volume identifier** field is a unique value assigned to the hdisk if the disk array is a member of a volume group. If the disk array is not a member of a volume group, this field value is none.
- The **Queue DEPTH** field is the depth of the command queue used for this disk array. For more information, see "Drive queue depth" on page 49
- The **Size in Megabytes** field represents the usable capacity of the disk array. For information about calculating capacities for each RAID level, see "Supported RAID levels" on page 21.
- The **RAID Level** field is the level of protection chosen for this array.
- The **Stripe Size in KB** field is the number of contiguous kilobytes that will be written to a single disk before switching to the next disk in the disk array. It provides the host with a method to tune data striping according to the typical I/O request size.

You cannot change any of the attributes on this screen. The RAID level and stripe size must be specified when the array is created.

Viewing IBM SAS pdisk settings

This procedure enables you to view SAS pdisk attributes and settings.

To view the SAS pdisk settings, complete the following steps:

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Change/Show SAS pdisk Status**.
3. Select **Change/Show SAS pdisk.**
4. Select a pdisk from the list.

The following attributes are displayed:

```
+------------------------------------------------------------------------------+
|                           Change/Show SAS pdisk                              |
|                                                                              |
|Type or select values in entry fields.                                        |
|Press Enter AFTER making all desired changes.                                 |
|                                                                              |
|                                                        [Entry Fields]        |
| Disk                                         pdisk11                          |
| Description                                  Physical SAS Disk Driv>          |
| Status                                       Available                        |
| Location                                     05-08-00                         |
| Serial Number                                00100DE3                         |
| Vendor and Product ID                        IBM     HUS151436VLS30>          |
| Service Level                                                                 |
| Size in Megabytes                            34898                            |
| Format Timeout in minutes                    [180]                        +#| |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|F1=Help          F2=Refresh        F3=Cancel         F4=List                  |
|F5=Reset         F6=Command        F7=Edit           F8=Image                 |
|F9=Shell         F10=Exit          Enter=Do                                   |
+------------------------------------------------------------------------------+
```

The **Size in Megabytes** field represents the capacity of the pdisk.

Viewing pdisk vital product data

You can display a pdisk's vital product data (VPD).

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Change/Show SAS pdisk Status**.
3. Select **Display pdisk Vital Product Data**.
4. Select the appropriate controller.
5. Select the pdisk that you want to view.

Viewing controller SAS addresses

View SAS addresses (worldwide IDs) associated with each of the controllers ports.

To view the serial-attached SCSI (SAS) addresses for each controller port, complete the following steps:

1. Start the IBM SAS Disk Array Manager by following the steps in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Show SAS Controller Physical Resources**.
4. Select a SAS controller from the list.

For information about the resulting display, see "Controller SAS address attributes."

Controller SAS address attributes

Interpret the results of viewing the controller SAS addresses.

After you perform the procedure described in "Viewing controller SAS addresses," information similar to the following is displayed:

```
+------------------------------------------------------------------------------+
|                             COMMAND STATUS                                   |
|                                                                              |
|Command: OK           stdout: yes           stderr: no                        |
|                                                                              |
|Before command completion, additional instructions can appear below.         |
|                                                                              |
|Adapter Port        SAS Address                                               |
|------------        -----------                                               |
|00                  5005076c07447c01                                          |
|01                  5005076c07447c02                                          |
|02                  5005076c07447c03                                          |
|03                  5005076c07447c04                                          |
|04                  5005076c07447c05                                          |
|05                  5005076c07447c06                                          |
|06                  5005076c07447c07                                          |
|07                  5005076c07447c08                                          |
|                                                                              |
|                                                                              |
|F1=Help            F2=Refresh          F3=Cancel          F6=Command          |
|F8=Image           F9=Shell            F10=Exit           /=Find              |
|n=Find Next                                                                   |
+------------------------------------------------------------------------------+
```

The SAS address is displayed for each adapter port as if each SAS port were a narrow port (in other words, the port consists of a single phy). Each SAS cable contains four phys that are typically organized into either a single 4x SAS wide port or two 2x SAS wide ports.

When using cables that create wide ports, the SAS address for the wide port will be the SAS address of the lowest-numbered adapter port in the wide port. For example, if the controller depicted in the preceding screen is connected with a 4x cable such as the AE cable, the SAS address of the controller on that wide port would be either 5005076c07447c01 or 5005076c07447c05, depending on which connector is used.

Note: Any single phy in a wide port can fail and might not be included as part of the wide port if the adapter is reset. This can result in the controller reporting a different SAS address from what was previously reported.

For example, a 4x wide port that contains ports 0 through 3 could respond to any of the SAS addresses listed for the adapter port, depending on which phys failed. Therefore, all addresses in the wide port are considered as possible controller addresses when managing access control using SAS zoning.

System software allocations for SAS controllers

AIX has system software resources allocated for the maximum number of attached devices, the maximum number of command elements, and the total size of all outstanding data transfers by active commands. The following procedures describe how to view and change those settings.

System software allocation is supported for the following AIX software levels:
- AIX Version 7.1 with Service Pack 3, or later
- AIX Version 6.1 with the 6100-06 Technology Level, and Service Pack 5, or later
- AIX Version 6.1 with the 6100-05 Technology Level, and Service Pack 6, or later
- AIX Version 6.1 with the 6100-04 Technology Level, and Service Pack 10, or later
- AIX Version 5.3 with the 5300-12 Technology Level and Service Pack 4, or later
- AIX Version 5.3 with the 5300-11 Technology Level and Service Pack 7, or later

Viewing system software allocations for SAS controllers

The AIX system has resources allocated to attached devices. Use this procedure to view the system software allocations and controller resource usage.

To view the system software allocations and controller resource usage, complete the following steps:
1. Navigate to the IBM SAS Disk Array Manager by completing the steps in "Using the Disk Array Manager" on page 33.
2. Click **Diagnostics and Recovery Options** > **Change/Show SAS RAID Controller**.
3. Select the IBM SAS RAID controller for which you want to view the resource usage.

You can obtain the same information from the command line by running the `lsattr` command on the SAS controller.

Changing system software allocations for SAS controllers

The AIX system has resources allocated to attached devices. Use this procedure to change the system software allocations for SAS controllers.

There are built-in limits for the maximum values that can be used for setting the driver resource allocation parameters. The adapter driver resource sizing limits vary depending on the adapter family. In addition, some of the limits are enforced by adapter hardware or system I/O resource allocation policies.

The AIX system software allocation attributes cannot be changed from the disk array manager displays. The attributes must be changed from the command line by running the `chdev` command on an unconfigured SAS controller. Optionally, you can run the `chdev` command on a configured SAS controller with the `-P` option. This action activates the change on the next configuration of the adapter.

The details of the driver resource allocation parameters and the maximum values that can be used for setting the parameters are provided in the following tables. See Table 7 on page 48, Table 8 on page 48, and Table 9 on page 48.

Attached Devices

The limit for the maximum number of physical devices that can be attached to the specified adapter family.

Table 7. Maximum number of attached devices

PCI-X and PCIe adapter family	PCIe2 adapter family
256	8000

Note: The value of the parameter `Maximum Number of Attached Devices` cannot be changed in the PCI-X and PCIe adapter family. The value can be changed in the PCIe2 adapter family.

Commands to Queue

The limits for the maximum number of commands that can be outstanding simultaneously to the specified adapter family.

Table 8. Maximum number of commands that can be outstanding

	PCI-X and PCIe adapter family	PCIe2 adapter family
Values for maximum number of commands	Multiples of 10	Multiples of 8
Maximum number of JBOD commands	980	984
Maximum number of RAID commands	890	984
Maximum number of SATA commands	980	984
Maximum sum of all JBOD, RAID, SATA commands	1000	1000

Data Transfer Window

The limits for the maximum total data transfer space (direct memory access space) that can be outstanding to the specified adapter family.

Table 9. Maximum total data transfer space

	PCI-X and PCIe adapter family	PCIe2 adapter family
Maximum JBOD command transfer space	1 GB - 48 MB (0x3D000000)	1 GB - 48 MB (0x3D000000)
Maximum RAID command transfer space	1 GB - 48 MB (0x3D000000)	1 GB - 48 MB (0x3D000000)
Maximum SATA command transfer space	1 GB - 48 MB (0x3D000000)	1 GB - 48 MB (0x3D000000)
Maximum sum of all JBOD, RAID, and SATA transfer spaces	1 GB (0x40000000)	1 GB (0x40000000)

Note: Specifying a value of zero for any device class (JBOD, RAID, or SATA) must be counted as 16 MB because the driver enforces a minimum window to protect against accidental prevention of any data transfer implied by a value of 0. The driver reserves 48 MB of space for this purpose, allowing a maximum individual (per class) size of 1 GB - 48 MB (0x3D000000) bytes.

Use the **chdev** command to change the attribute for the specific system software resource allocation.

The following sections provide information about the usage of the **chdev** command to change the attributes.

Attached devices

Use the **chdev** command with the **max_devices** attribute on the SAS controller as shown in the following example:

```
chdev -1 sissasN -a " max_devices=value "
```

Where:

* *sissasN* represents the name of a SAS controller.
* *value* is the value you assign for the maximum number of attached devices that you want the AIX software to be prepared to handle.

Note: The default attached devices might be sufficient. This setting must never be less than the default, because you might not be able to reboot the system.

Commands to queue

Use **chdev** to set the **max_cmd_elems** attribute on the SAS controller as shown in the following example:

```
chdev -1 sissasN -a " max_cmd_elems=value_JBOD,value_RAID,value_SATA "
```

Where:

- *sissasN* represents the name of a SAS controller.
- *value_JBOD* is the value you assign for the maximum number of JBOD commands.
- *value_RAID* is the value you assign for the maximum number of RAID commands.
- *value_SATA* is the value you assign for the maximum number of SATA commands that you want the AIX software to handle.

Data transfer window

Use **chdev** to set the **max_dma_window** attribute on the SAS controller as shown in the following example: `chdev -1 sissasN -a " max_dma_window=value_JBOD,value_RAID,value_SATA "`

Where:

- *sissasN* represents the name of a SAS controller.
- *value_JBOD* is the value you assign for the maximum JBOD command transfer space.
- *value_RAID* is the value you assign for the maximum RAID command transfer space.
- *value_SATA* is the value you assign for the maximum SATA command transfer space that you want the AIX software to handle.

Examples

- To configure sissas1 for a maximum of 100 commands to RAID arrays and have it take effect now:

```
rmdev -Rl sissas1

chdev -l sissas1 -a max_cmd_elems=0,100,0

cfgmgr
```

- To leave sissas1 unchanged for now, but set it to take effect when configured next time, for example, the next time you boot:

```
chdev -l sissas1 -a max_cmd_elems=0,100,0 -P
```

- To configure sissas2 to use the maximum data transfer window for RAID while leaving minimal resources to allow a few JBOD and SATA commands to run through:

```
rmdev -Rl sissas2

chdev -l sissas2 -a max_dma_window=0,0x3D000000,0

cfgmgr
```

Drive queue depth

For performance reasons, you might want to change the disk command queue depth. The disk queue depth limits the maximum number of commands that AIX software can issue concurrently to that disk at any time. Increasing a disk queue depth might improve disk performance by increasing disk throughput (or I/O) but might also increase latency (response delay). Decreasing a disk queue depth might improve disk response time but decrease overall throughput. The queue depth is viewed and changed on each individual disk. When changing the disk queue depth, the command elements and data transfer window on the parent adapter might also need to be changed.

System software allocation is supported for the following AIX software levels:

- AIX Version 7.1 with Service Pack 3, or later
- AIX Version 6.1 with the 6100-06 Technology Level, and Service Pack 5, or later

- AIX Version 6.1 with the 6100-05 Technology Level, and Service Pack 6, or later
- AIX Version 6.1 with the 6100-04 Technology Level, and Service Pack 10, or later
- AIX Version 5.3 with the 5300-12 Technology Level and Service Pack 4, or later
- AIX Version 5.3 with the 5300-11 Technology Level and Service Pack 7, or later

Viewing the drive queue depth

To view the current queue depth on any disk (JBOD or RAID), use the **lsattr** command from the AIX command line.

The **queue_depth** attribute contains the current setting. The default value for the disk queue depth is determined by the adapter family.

Table 10. Drive queue depth for different adapter families

	PCI-X and PCIe adapter family	PCIe2 adapter family
Default JBOD disk queue depth	16	16
Default RAID disk queue depth	4 times the number of pdisks in the RAID array	16 times the number of pdisks in the RAID array

Example

To list the current **queue_depth** attribute value for the hdisk2 disk, type the following command:

```
lsattr -E -l hdisk2 -a queue_depth
```

The system displays a message similar to the following: queue_depth 64 Queue DEPTH True

Changing the drive queue depth

You can change the drive queue depth from the command line by running the **chdev** command.

Changing the disk queue depth on RAID disks for the PCI-X and PCIe adapter family is different from RAID disks on PCIe2 adapter family. Changing the disk queue depth on JBOD disks is common across all SAS adapter families. The following sections provide information about the use of the **chdev** command for the different adapter families.

Setting Queue Depth JBOD disks and RAID disks on PCIe2 adapter family
  Use the **chdev** command with the **queue_depth** attribute on the JBOD or RAID disk as in the following example:

```
chdev -1 hdiskN -a " queue_depth =value "
```

  Where *hdiskN* represents the name of a JBOD or RAID disk and *value* is the value you assign for the disk queue depth.

Setting Queue Depth on RAID on PCI-X and PCIe adapter family
  The RAID disks on the PCI-X and PCIe adapter family cannot be changed individually on a per-disk basis. The RAID disks on these adapters have a coarse grain control where the parent adapter has an attribute that controls the queue depth multiple per pdisk. This attribute affects all RAID disks under that adapter. The overall queue depth used for an individual RAID array under that adapter is the queue depth multiple per pdisk value times the number of physical disks that make up the RAID array.

  Use the **chdev** command with the **qdpth_per_pdisk** attribute on the SAS controller as in the following example:

```
chdev -1 sissasN -a " qdpth_per_pdisk=value "
```

  Where *sissasN* represents the name of a SAS controller and *value* is the queue depth multiplier per pdisk to be used for all RAIS arrays under the *sissasN* adapter.

Example

- To configure hdisk1 (JBOD or RAID on the PCIe2 adapter) for a maximum queue depth of 48:

  ```
  chdev -l hdisk1-a queue_depth=48
  ```

  The system displays a message similar to the following: `queue_depth 64 Queue DEPTH True`
- To configure all RAID hdisks under PCI-X/ and PCIe adapter sissas2 to use a queue depth multiplier per pdisk of 8 and have it take effect now:

  ```
  rmdev -Rl sissas2

  chdev -l sissas2 -a qdpth_per_pdisk=8

  cfgmgr
  ```
- To leave all RAID disks under sissas2 unchanged for now, but set it to take effect when configured next time, for example, the next time you boot:

  ```
  chdev -l sissas2 -a qdpth_per_pdisk=8 -P
  ```

AIX command-line interface

Many tasks used to manage the SAS RAID controller can be performed by using the AIX command line instead of using the SAS Disk Array Manager.

The following table summarizes the commands used in the command line interface.

Table 11. AIX Commands

Task	Command
General Help	sissasraidmgr -h
Viewing the Disk Array Configuration	sissasraidmgr -Ll *controller name* -j1
Preparing Disks for Use in SAS Disk Arrays	sissasraidmgr -P -z *disk list* (For example, sissasraidmgr -P -z hdisk1 hdisk2 pdisk3 pdisk4)
Changing pdisks to hdisks	sissasraidmgr -U -z *pdisk list*
Creating a SAS Disk Array	sissasraidmgr -C -r *raid level* -s *stripe size* -z *pdisk list*
Deleting a SAS Disk Array	sissasraidmgr -D -l *controller name* -d *array name*
Adding Disks to an Existing Disk Array	sissasraidmgr -A -l *array name* -z *pdisk list*
Creating Hot Spare Disks	sissasraidmgr -H -z *pdisk list*
Deleting Hot Spare Disks	sissasraidmgr -I -z *pdisk list*
Displaying Rechargeable Battery Information	sissasraidmgr -M -o0 -l *adapter name*
Forcing a Rechargeable Battery Error	sissasraidmgr -M -o1 -l *adapter name*
Recovering from Disk Failures	sissasraidmgr -R -z *pdisk list*
Viewing the SAS device resource locations	sissasraidmgr -Z -o0 -j3 -l *adapter name*
Viewing the SAS device resource information	sissasraidmgr -Z -o1 -j3 -l *adapter name*
Viewing the SAS path information for the attached device	sissasraidmgr -T -o1 -j3 -l *device name*
Viewing the SAS path information graphically for the attached device	sissasraidmgr -T -o0 -j3 -l *device name*
JBOD workload optimization for I/O response time	sissasraidmgr -J -o1 -z *hdisk list*
JBOD workload optimization for I/O operations per second	sissasraidmgr -J -o2 -z *hdisk list*

Considerations for solid-state drives (SSDs)

It is important to understand controller functions when using solid-state drives (SSDs).

Hard-disk drives (HDDs) use a spinning magnetic platter to store nonvolatile data in magnetic fields. SSDs are storage devices that use nonvolatile solid-state memory (usually flash memory) to emulate HDDs. HDDs have an inherent latency and access time caused by mechanical delays in the spinning of the platter and movement of the head. SSDs greatly reduce the time to access the stored data. The nature of solid-state memory is such that read operations can be performed faster than write operations and that write cycles are limited. Using techniques such as wear leveling and overprovisioning, enterprise-class SSDs are designed to withstand many years of continuous use.

SSD usage specifications

- Intermixing of SSDs and HDDs within the same disk array is not allowed. A disk array must contain all SSDs or all HDDs.
- It is important to plan for hot-spare devices when using arrays of SSDs. An SSD hot-spare device is used to replace a failed device in an SSD disk array and an HDD hot-spare device is used for an HDD disk array
- Although SSDs can be used in a RAID 0 disk array, it is preferred that SSDs to be protected by RAID levels 5, 6, or 10.
- See Installing and configuring Solid-state drives to identify specific configuration and placement requirements related to the SSD devices.
- Some adapters, known as RAID and SSD adapters, contain SSDs, which are integrated on the adapter. See the PCIe SAS RAID card comparison table for features and additional information for your specific adapter type.

RAID 0 Auto-created Disk Array

SSD devices are included in 528 bytes per sector Array Candidate pdisk format. During the controller's boot process, any SSD Array Candidate pdisk that is not already part of a disk array is automatically created as a single drive RAID 0 disk array. There are two options to change the RAID 0 disk array to a protected RAID level (5, 6, or 10):

- The RAID 0 disk array can be migrated to a RAID 10 disk array using the technique described in "Migrating an existing disk array to a new RAID level" on page 36.
- The auto-created RAID 0 disk array may be deleted (see "Deleting a disk array" on page 39) and a new SSD disk array created with a different level of RAID protection (see "Creating a disk array" on page 35).

Adapter Cache Control

Adapter caching improves overall performance by using disk drives. In some configurations, adapter caching might not improve performance when you use SSD disk arrays. In these situations adapter caching might be disabled by using the Change/Show SAS Controller display.

To disable adapter caching, complete the following steps:

1. Navigate to the IBM SAS Disk Array Manager by completing the steps in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Change/Show SAS RAID Controller**.
4. Select the IBM SAS RAID Controller on which to disable caching.
5. Select **Adapter Cache** and change the value to **Disabled**. The display looks similar to the following example.

```
+-------------------------------------------------------------------------------+
|                        Change/Show SAS Controller                     |
|                                                                       |
|Type or select values in entry fields.                                 |
|Press Enter AFTER making all desired changes.                          |
|                                               [Entry Fields]          |
|  SAS adapter                                  sissas0                 |
|  Description                                  PCIe2 1.8GB Cache RAID>  |
|  Status                                       Available               |
|  Location                                     0C-08                   |
|  Maximum Number of Attached Devices           512                     |
|  Maximum number of COMMANDS to queue to the adapter  100,300,0        |
|  Maximum Data Transfer Window                 0x1000000,0x5000000,0x>  |
|  Operating mode                               Primary Adapter         |
|  Adapter cache                                Disabled             +  |
|  Preferred HA Dual Initiator Operating mode    No Preference        + |
|  Dual HA Access State Setting                 Preserve             +  |
|  Dual Initiator Configuration                 Default              +  |
|  Serial Number                                YL3229016F9F            |
|  World Wide ID                                5005076c07445200         |
|  Remote HA Link Operational                   No                      |
|  Remote HA Serial Number                                          |   |
|  Remote HA World Wide ID                                        |     |
|  Attached AWC Link Operational                                        |
|  Attached AWC Serial Number                                           |
|  Attached AWC World Wide ID                                           |
|                                                                       |
|F1=Help          F2=Refresh       F3=Cancel         F4=List            |
|F5=Reset         F6=Command       F7=Edit           F8=Image           |
|F9=Shell         F10=Exit         Enter=Do                             |
+-------------------------------------------------------------------------------+
```

JBOD Workload Optimization

Additional optimization parameters are available through the **sissasraidmgr** utility for the PCIe RAID and SSD SAS adapter 3 Gb x8 (FC 2053/2054/2055; CCIN 57CD) when using SSD module CCIN 58B2. The **sissasraidmgr** provides a command line function which may enhance I/O performance for some types of I/O workloads. See table 1 in AIX command line interface to see the complete command string. The command for workload optimization is used to prepare JBOD-only formatted SSDs (512 byte) for this performance tuning. The I/O response time optimization may provide improved I/O performance for response-time sensitive workloads. The

default I/O per second optimization is generally preferred for higher command throughput (I/O per second). The JBOD workload optimization setting can be returned to its default value by either executing an I/O per second workload optimization command, recycling the power on the PCIe RAID and SSD SAS adapter, or downloading firmware to the SSD. It is recommended that a script be established to ensure the desired JBOD workload optimization parameters are activated whenever one of these actions occurs.

Multi-initiator and high availability

You can increase availability using multi-initiator and high availability to connect multiple controllers to a common set of disk expansion drawers.

The terms multi-initiator and high availability (HA) refer to connecting multiple controllers (typically two controllers) to a common set of disk expansion drawers for the purpose of increasing availability. This is commonly done in either of the following configurations:

HA two-system configuration

> An HA two-system configuration provides a high-availability environment for system storage by enabling two systems or partitions to have access to the same set of disks and disk arrays. This feature is typically used with the IBM PowerHA® for AIX. The IBM PowerHA for AIX software provides a commercial computing environment that ensures that mission-critical applications can recover quickly from hardware and software failures.

> The HA two-system configuration is intended for using disk arrays. The disks must be formatted to 528 bytes per sector. Any RAID level, or combination of RAID levels, can be used.

> Use of disks without RAID (referred to as JBOD) is also possible. The disks must be formatted to 512 bytes per sector. This JBOD alternative is supported only on particular controllers and requires unique setup and cabling. See "Installing an HA two-system JBOD configuration" on page 74.

HA single-system configuration

> An HA single-system configuration provides for redundant controllers from a single system to the same set of disks and disk arrays. This feature is typically used with multipath I/O (MPIO). MPIO support is part of AIX and can be used to provide a redundant IBM SAS RAID controller configuration with RAID protected disks.

> When using an HA single-system configuration, the disks must be formatted to 528 bytes per sector and used in one or more disk array. Any RAID level, or combination of RAID levels, might be used. Disks formatted to 512 bytes per sector are not supported in an HA single-system configuration.

Not all controllers support all configurations. See the feature comparison tables for PCIe and PCI-X cards to look for controllers that have HA two-system RAID, HA two-system JBOD, or HA single-system RAID marked as Yes for the configuration that you want.

Related concepts:

"PCI-X SAS RAID card comparison" on page 4
This table compares the main features of PCI-X SAS RAID cards.

"PCIe SAS RAID card comparison" on page 9
Use the tables provided here to compare the main features of PCI Express (PCIe) SAS RAID cards.

Possible HA configurations

Possible HA configurations are summarized here.

Table 12. SAS RAID and JBOD HA configurations

Multi-initiator configuration	HA two system (for example HACMP™)	HA single system (for example MPIO)
RAID (disks formatted 528 bytes per sector)	• Maximum of two controllers • Both controllers must have same write cache capability and write cache sizes • Both controllers must support HA two-system RAID • Controllers are in different systems or partitions	• Maximum of two controllers • Both controllers must have same write cache capability and write cache sizes • Both controllers must support HA single-system RAID • Controllers are in the same system or partition
JBOD (disks formatted 512 bytes per sector)	• Maximum of two controllers • Both controllers must support HA two-system JBOD • Controllers are in different systems or partitions • Requires unique setup and cabling	• Supported by Multipath IO software

The following figures illustrate an example of each configuration.

HA Two System RAID
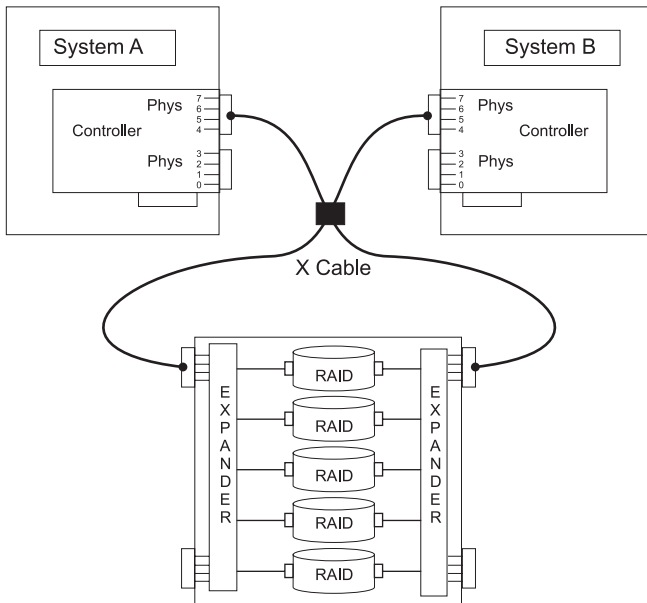
AREBJ514-0

HA Single System RAID
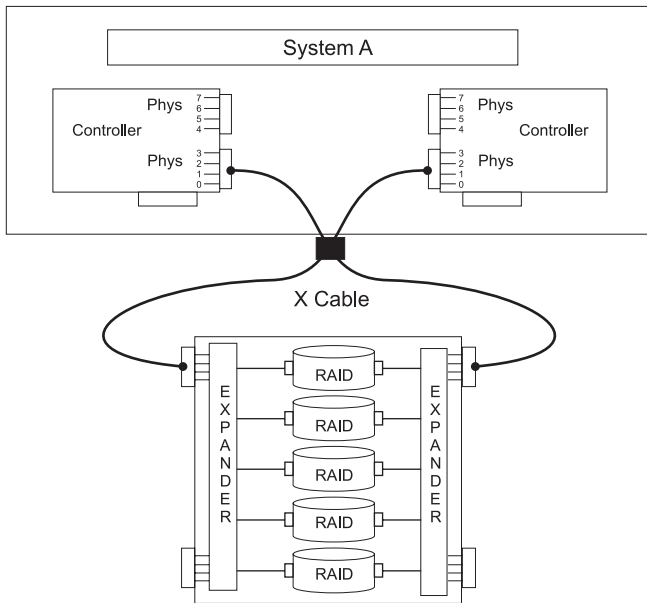
AREBJ515-0

HA Two System JBOD
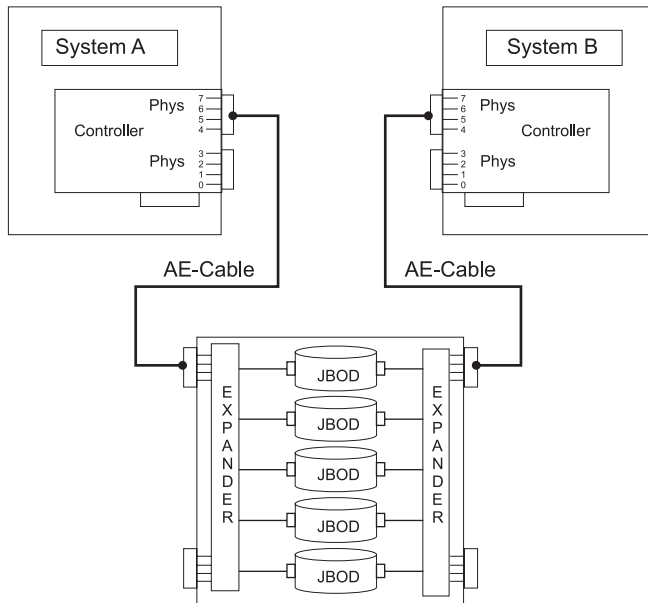
Controller functions

Consider these factors when using multi-initiator and HA functions.

Use of the multi-initiator and HA functions require controller and AIX software support. Controller support is shown in the feature comparison tables for PCIe and PCI-X cards. Look for controllers that have HA two-system RAID, HA two-system JBOD, or HA single-system RAID marked as Yes for the configuration that you want. The AIX software levels required for multi-initiator support are identified in the AIX software requirements table.

Specific controllers are intended only to be used in either an HA two-system RAID or HA single-system RAID configuration. Use the feature comparison tables for PCIe and PCI-X cards to look for controllers that have Requires HA RAID configuration marked as Yes. This type of controller cannot be used in an HA two-system JBOD or a stand-alone configuration.

Controllers connected in a RAID configuration must have the same write cache size (given they support write cache). A configuration error will be logged if the controllers' write caches are not the same size.

When configuring a controller for an HA two-system RAID or HA single-system RAID configuration, no mode jumpers or special configuration settings are needed. However, when configuring a controller for an HA two-system JBOD configuration, the **Dual Initiator Configuration** must be changed to a value of `JBOD HA Single Path`.

For all HA RAID configurations, one controller functions as the primary controller. Primary controllers perform management of the physical devices, such as creating a disk array, downloading SES microcode and downloading disk microcode. The other controller functions as the secondary and is not capable of physical device management.

If the secondary controller detects the primary controller going offline, it will switch roles to become the primary controller. When the original primary controller comes back online, it will become the secondary controller. The exception to this case is if the original primary controller was previously designated as the preferred primary controller.

Both controllers are capable of performing direct I/O accesses (read and write operations) to the disk arrays. At any given time, only one controller in the pair is optimized for the disk array. The controller optimized for a disk array is the one that directly accesses the physical devices for I/O operations. The controller that is not optimized for a disk array will forward read and write requests, through the SAS fabric, to the optimized controller.

The primary controller logs most errors that are related to problems with a disk array. Disk array errors might also be logged on the secondary controller if a disk array is optimized on the secondary controller at the time the error occurred.

Typical reasons for the primary and secondary controllers to switch roles from what was expected or preferred are as follows:

- Controllers will switch roles for asymmetric reasons. For example, one controller detects more disk drives than the other. If the secondary controller is able to find devices that are not found by the primary controller, an automatic transition (failover) occurs. The controllers will communicate with each other, compare device information, and switch roles.
- Powering off the primary controller or the system that contains the primary controller causes an automatic transition (failover) to occur.
- Failure of primary controller or the system that contains the primary controller causes an automatic transition (failover) to occur.
- If the preferred primary controller is delayed in becoming active, the other controller assumes the role of primary controller. After the preferred primary controller becomes active, an automatic transition (failover) occurs.
- If the primary controller loses contact with the disks that are also accessible by the secondary controller, an automatic transition (failover) occurs.
- Downloading controller microcode might cause an automatic transition (failover) to occur.

For all JBOD configurations, both controllers function only as stand-alone controllers and do not communicate directly with each other.

Users and their applications are responsible to ensure orderly read and write operations to the shared disks or disk arrays, for example, by using device reservation commands (persistent reservation is not supported).

Related concepts:

"PCI-X SAS RAID card comparison" on page 4
This table compares the main features of PCI-X SAS RAID cards.

"PCIe SAS RAID card comparison" on page 9
Use the tables provided here to compare the main features of PCI Express (PCIe) SAS RAID cards.

"HA access optimization" on page 62
HA access characteristics can balance the controller workload.

Related tasks:

"Installing an HA two-system JBOD configuration" on page 74
Use this procedure to help you to install an HA two-system JBOD configuration.

Controller function attributes

Compare important attributes of controller functions.

Table 13. SAS controller functions

Controller functions	HA two-system RAID configuration	HA two-system JBOD configuration	HA single-system RAID configuration
512 bytes per sector disks supported	No[1]	Yes	No[1]
528 bytes per sector disks supported	Yes	No	Yes
Mirrored write cache between controllers (for controllers which have write cache)	Yes		Yes
Mirrored RAID parity footprints between controllers	Yes		Yes
Dual paths to disks	Yes	No	Yes
Target mode initiator device support	Yes	No	No
Only IBM qualified disk drives supported	Yes	Yes	Yes
Only IBM qualified disk expansion drawer supported	Yes	Yes	Yes
Tape or optical devices supported	No	No	No
Boot support	No	No	Yes
Operating mode[2]	Primary adapter or secondary adapter[3]	Stand-alone adapter[3]	Primary adapter or secondary adapter[3]
Preferred dual initiator operating mode[2]	No preference or primary[3]	No preference[3]	No preference or primary[3]
Dual initiator configuration[2]	Default[3]	JBOD HA single path[3]	Default[3]
Manage HA access characteristics[4]	Yes	No	Yes

1. 512 bytes per sector disks are not to be used functionally, but will be available to be formatted to 528 bytes per sector.
2. Can be viewed by using the Change/Show SAS Controller screen.
3. This option can be set by using the Change/Show SAS Controller screen.
4. For information on managing the HA access characteristics for a disk array, see "HA access optimization" on page 62.

Viewing HA controller attributes

For HA configuration-related information, use the Change/Show SAS Controller screen.

1. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Change/Show SAS RAID controller**.
4. Select the IBM SAS RAID Controller. The screen displayed will look similar to the following example.

```
+------------------------------------------------------------------------------+
|                        Change/Show SAS Controller                            |
|                                                                              |
| Type or select values in entry fields.                                       |
| Press Enter AFTER making all desired changes.                                |
|                                                                              |
|                                                     [Entry Fields]           |
|    SAS adapter                                      sissas2                   |
|    Description                                      PCIe2 1.8GB Cache RAID>   |
|    Status                                           Available                 |
|    Location                                         06-00                     |
|    Maximum Number of Attached Devices               512                       |
|    Maximum number of COMMANDS to queue to the adapter  100,300,0              |
|    Maximum Data Transfer Window                     0x1000000,0x5000000,0x>   |
|    Operating mode                                   Primary Adapter      +   |
|    Adapter Cache                                    Default               +   |
|    Preferred HA Dual Initiator Operating mode       No Preference         +   |
|    Preferred HA Access State Setting                Preserve              +   |
|    Dual Initiator Configuration                     Default                   |
|    Serial Number                                    YL3126327310              |
|    World Wide ID                                    5005076c0702bf00          |
|    Remote HA Link Operational                       Yes                       |
|    Remote HA Serial Number                          07127001                  |
|    Remote HA World Wide ID                          5005076c0702f600          |
|    Remote AWC Link Operational                      No                        |
|    Remote AWC Serial Number                                                   |
|    Remote AWC World Wide ID                                                   |
|                                                                              |
|                                                                              |
| F1=Help            F2=Refresh          F3=Cancel          F4=List             |
| F5=Reset           F6=Command          F7=Edit            F8=Image            |
| F9=Shell           F10=Exit            Enter=Do                               |
+------------------------------------------------------------------------------+
```

> **Note:** For additional details on how to set up a configuration, see "Installing an HA single-system RAID configuration" on page 66 or "Installing an HA two-system JBOD configuration" on page 74.

HA cabling considerations

There are different types of cables to consider with high availability.

Correct cabling is one of the most important aspects of planning for a multi-initiator and HA configuration. For RAID configurations with disk expansion drawers, correct cabling is required to provide redundancy between each controller and the disk expansion drawer. For JBOD configurations, correct cabling is required, but generally provides much less redundancy between each controller and the disk expansion drawer. Thus there is better SAS fabric redundancy for RAID configurations versus JBOD configurations.

To see examples of how to cable HA configurations, see the section entitled Serial attached SCSI cable planning.

Note: Some systems have SAS RAID adapters integrated on the system boards. Separate SAS cables are not required to connect the two integrated SAS RAID adapters to each other.

HA performance

Controller failures can impact performance.

The controller is designed to minimize performance impacts when running in an HA configuration. When using RAID 5, 6, and 10, parity footprints are mirrored between the controller's nonvolatile memory, which causes only a slight impact to performance. For controllers with write cache, all cache data is mirrored between the controller's nonvolatile memories, which also causes only a slight impact to performance.

If one controller fails in an HA configuration, the remaining controller will disable write caching and begin to keep an additional copy of parity footprints on disk. This can significantly impact performance, particularly when using RAID 5 and RAID 6.

HA access optimization

HA access characteristics can balance the controller workload.

With either of the HA RAID configurations, maximum performance might be achieved by defining HA access characteristics for each disk array such that the workload is balanced between the two controllers. Setting the HA access characteristics for a disk array specifies which controller is preferred to be optimized for the disk array and perform direct read and write operations to the physical devices.

Figure 28. HA access optimization

View the HA access characteristics by completing the following steps.

1. Navigate to the **IBM SAS Disk Array Manager** by using the steps found in "Using the Disk Array Manager" on page 33

2. Select **Manage HA Access Characteristics of a SAS Disk Array**.

3. Select the IBM SAS RAID controller.

HA access characteristics are displayed on the IBM SAS Disk Array Manager screen, similar to the following screen.

```
+-------------------------------------------------------------------------------+
|                        IBM SAS Disk Array Manager                             |
| Move cursor to desired item and press Enter.                                  |
|  List SAS Disk Array Configuration                                            |
|  Create an Array Candidate pdisk and Format to 528 Byte Sectors               |
|  Create a SAS Disk Array                                                       |
|  Delete a SAS Disk Array                                                       |
|  Add Disks to an Existing SAS Disk Array                                       |
|  Migrate an Existing SAS Disk Array to a New RAID Level                        |
|  Configure a Defined SAS Disk Array                                            |
|  +-------------------------------------------------------------------------+   |
|  |             HA Access Characteristics of a SAS Disk Array               |   |
|  |                                                                         |   |
|  | Move cursor to desired item and press Enter.                            |   |
|  |                                                                         |   |
|  |   hdisk3        Current=Optimized        Preferred=Non Optimized        |   |
|  |   hdisk4        Current=Non Optimized    Preferred=Non Optimized        |   |
|  |   hdisk5        Current=Optimized        Preferred=Optimized            |   |
|  |   hdisk6        Current=Optimized        Preferred=Optimized            |   |
|  |                                                                         |   |
|  | F1=Help            F2=Refresh            F3=Cancel                      |   |
|  | F8=Image           F10=Exit             Enter=Do                        |   |
|F1| /=Find             n=Find Next                                          |   |
|F9+-------------------------------------------------------------------------+   |
+-------------------------------------------------------------------------------+
```

This display shows the HA access characteristics for the disk arrays with respect to the controller that was selected. For each disk array listed, the current and preferred HA access characteristics are indicated. The current value shows how the disk array is currently accessed from the controller that was selected. The preferred value is the desired access state that is saved with the disk array configuration. Selecting the remote controller would show the opposite settings for the current and preferred access states.

The following access state settings are valid.

Optimized
> The selected controller performs direct access for this disk array. This gives I/O operations that are performed on selected controller optimized performance compared to the remote controller.

Non Optimized
> The selected controller performs indirect access for this disk array. This gives I/O operations that are performed on selected controller nonoptimized performance compared to the remote controller.

Cleared

> Neither an Optimized nor Non Optimized access state has been set for this disk array. By default the disk array is optimized on the primary controller.

The HA access characteristic can be displayed on either the primary or secondary controller. However, as with all other disk array management, the HA access characteristics can only be changed from the primary controller. Setting the preferred HA access characteristic is accomplished by selecting one of the disk arrays. This will bring up the **Change/Show HA Access Characteristics of a SAS Disk Array** screen. The **Preferred Access** state can be changed when the disk array is selected from the primary controller. The **Preferred Access** state cannot be changed if the disk array is selected from the secondary controller. If this is attempted, an error message is displayed. Changing the **Preferred Access** state from the primary controller stores the settings in the disk array and automatically shows the opposite settings when viewed from the secondary controller.

```
+------------------------------------------------------------------------------+
|            Change/Show HA Access Characteristics of a SAS Disk Array          |
|                                                                              |
|Type or select values in entry fields.                                        |
|Press Enter AFTER making all desired changes.                                 |
|                                                                              |
|                                                      [Entry Fields]          |
|  Disk Array                                         hdisk4                    |
|  Controller                                         sissas0                   |
|  Current Access                                     Optimized                 |
|  Preferred Access                                   Cleared              +    |
|                                                                              |
|F1=Help            F2=Refresh         F3=Cancel          F4=List               |
|F5=Reset           F6=Command         F7=Edit            F8=Image              |
|F9=Shell           F10=Exit           Enter=Do                                 |
+------------------------------------------------------------------------------+
```

The controller always tries to switch the Current Access state of the disk array to match the Preferred Access state. This switching is done in the background by the controller; therefore, you might experience delays between setting the Preferred Access state and seeing Current Access state switch. The delay can be minutes before the switch occurs, especially on caching adapters that need to flush cache before the Current Access state can switch. Situations in which the controller does not switch HA access characteristics involve configuration errors, failed components, and certain RAID configuration activities.

By default all disk arrays are created with a Preferred Access state of `Cleared`. To maximize performance, when appropriate, create multiple disk arrays and optimize them equally between the controller pair. This is accomplished by setting the Preferred Access to `Optimized` for half of the disk arrays and `Non Optimized` to the other half.

The HA access characteristics can also be altered by the Preferred HA Access State Setting in the Change/Show SAS RAID controller screen. This field gives the option to either Preserve or Clear the Preferred Access settings for all disk arrays on the controller pair.

HA access characteristics within List SAS Disk Array Configuration

You can view the current and preferred access states in the Description column for the disk arrays.

The **List SAS Disk Array Configuration** option in the IBM SAS Disk Array Manager will display the current and preferred access states in the Description column for the disk arrays. The current and preferred access states will be displayed after the description of the disk array (similar to the display HA access optimization) where the entries in the two descriptive columns indicate **O** for Optimized and **N** for Non Optimized. The following sample output is displayed when the List SAS Disk Array Configuration option is selected.

Note: The HA access characteristics are only displayed for disk arrays with a **Preferred Access** state other than `Cleared`. Disk arrays with a `Cleared` **Preferred Access** state, by default, are optimized on the primary adapter.

```
+--------------------------------------------------------------------------------+
|                             COMMAND STATUS                                     |
|                                                                                |
| Command: OK            stdout: yes            stderr: no                        |
|                                                                                |
| Before command completion, additional instructions can appear below.           |
|                                                                                |
|                                                                                |
| --------------------------------------------------------------------            |
| Name      Resource  State       Description            Size                    |
| --------------------------------------------------------------------            |
| sissas1   FFFFFFFF  Secondary   PCIe x8 Ext Dual-x4 3 Gb SAS RAID Adapter       |
| tmscsi0   00FE0000  HA Linked   Remote adapter SN  081630F1                     |
|                                                                                |
| hdisk3    00FF0000  Optimal     RAID 5 Array (O/N)    139.5GB                   |
|  pdisk4   00000000  Unknown     Array Member               N/A                 |
|  pdisk5   00000200  Unknown     Array Member               N/A                 |
|  pdisk7   00000400  Unknown     Array Member               N/A                 |
|                                                                                |
| hdisk4    00FF0100  Optimal     RAID 6 Array (N/N)    139.5GB                   |
|  pdisk13  00000100  Unknown     Array Member               N/A                 |
|  pdisk6   00000300  Unknown     Array Member               N/A                 |
|  pdisk8   00000500  Unknown     Array Member               N/A                 |
|  pdisk14  00000700  Unknown     Array Member               N/A                 |
|                                                                                |
| hdisk5    00FF0200  Optimal     RAID 10 Array (O/O)   139.5GB                   |
|  pdisk9   00000600  Unknown     Array Member               N/A                 |
|  pdisk11  00000900  Unknown     Array Member               N/A                 |
|                                                                                |
| hdisk6    00FF0700  Optimal     RAID 0 Array (O/O)     69.7GB                   |
|  pdisk12  00000B00  Unknown     Array Member               N/A                 |
|                                                                                |
|                                                                                |
| F1=Help            F2=Refresh        F3=Cancel         F6=Command               |
| F8=Image           F9=Shell          F10=Exit          /=Find                   |
| n=Find Next                                                                     |
+--------------------------------------------------------------------------------+
```

Related tasks:
Use this procedure to view SAS disk array configurations on your server.

Configuration and serviceability considerations for HA RAID configurations

There are configuration and serviceability differences between the primary and secondary controllers.

There are configuration and serviceability differences between the primary controller (which performs direct management of the physical devices) and the secondary controller (which runs as a client of the primary controller). This functional difference requires many of the configuration and serviceability

functions to be performed on the primary controller because it is the only controller that can perform the commands. Attempting these commands on a secondary controller is not recommended and might return unexpected results.

The following are common tasks within iprconfig that must be performed from the primary controller:
* Under the iprconfig menu option titled **Display Hardware Status:**:
    – Show Advanced Function Disk information unless configured as a RAID member or a hot spare
* Under the iprconfig menu option titled **Work with disk arrays:**:
    – Create a disk array
    – Delete a disk array
    – Add a device to a disk array
    – Format device for RAID function
    – Format device for JBOD function
    – Create a hot spare
    – Delete a hot spare
    – View/Change asymmetric access states of RAID arrays
    – Force RAID Consistence Check
    – Migrate disk array protection
* Under the iprconfig menu option titled **Work with Disk Unit Recovery:**:
    – Concurrent add device
    – Concurrent remove device
    – Initialize and format disk unless disk was formatted in JBOD format
    – Reclaim IOA cache storage
    – Rebuild disk unit data
    – Force RAID Consistency Check
    – Display SAS path status unless the disk is a JBOD disk
* Under the iprconfig menu option titled **Work with disk configuration:**:
    – Change Disk Configuration
* Under the iprconfig menu option titled **Work with adapter configuration:**:
    – Change Adapter Configuration to enable Active/Active mode
* Under the iprconfig menu option titled **Download microcode:**:
    – Download microcode to RAID member, hot spare, and Advanced function disk.
    – Download microcode to SAS enclosure

Installing high availability

Use the procedures in this section when performing HA installations.

Installation procedures are described for an HA two-system RAID configuration, an HA single-system RAID configuration, and an HA two-system JBOD configuration.

Installing an HA single-system RAID configuration

Use this procedure to help you to install an HA single-system RAID configuration.

To avoid problems during installation, follow the steps exactly as written.

Attention: Disk Arrays can be created either before or after the HA RAID configuration is set up. See "Configuration and serviceability considerations for HA RAID configurations" on page 65 for important considerations.

1. Install and update the AIX SAS controller package on each system or partition. See "Controller software" on page 31 for more information.

   Attention: If you believe the controller might have been used in a **JBOD HA Single Path** Dual Initiator configuration, do not attach cables in any HA RAID configuration. Disconnect all cables and change the controller's **Dual Initiator Configuration** to **Default** before using the controller in an HA RAID configuration.

2. Install the SAS controllers into the system or partition. Do not attach any cables to the SAS controllers at this time.

3. Update each controller to the latest SAS controller microcode from the code download Web site. See "Updating the SAS RAID controller microcode" on page 78.

4. To prevent errors while connecting the cables, unconfigure the SAS controller on each system or partition:

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Unconfigure an Available SAS RAID controller**.

      Note: In some environments, it might not be possible to unconfigure the controllers. To perform an error-free installation in these environments, perform a normal shutdown of the system or partition before you attach the cables.

5. Attach an appropriate cable from the shared disk expansion drawer to the same SAS connector on each controller. To see examples of how to cable the HA configurations, see Serial attached SCSI cable planning.

6. Configure the SAS controllers (or power on system or partition if powered off earlier):

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Configure a Defined SAS RAID controller**.

7. Verify that the cabling and functioning of the controllers are correct by using the Change/Show SAS Controller screen. Each controller should show an operational **Remote HA Link** to the other SAS controller. View the HA RAID link status by using the Change/Show SAS Controller screen:

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Change/Show SAS RAID controller**.

   d. Select the desired IBM SAS controller. The Change/Show SAS Controller information screen displays information similar to the following examples:

```
+------------------------------------------------------------------------------+
|                        Change/Show SAS Controller                            |
| Type or select values in entry fields.                                       |
| Press Enter AFTER making all desired changes.                                |
|                                                                              |
|                                                   [Entry Fields]             |
|   SAS adapter                                     sissas0                     |
|   Description                                     PCI-X266 Ext Dual-x4 3>     |
|   Status                                          Available                   |
|   Location                                        0E-08                       |
|   Maximum Number of Attached Devices              512                         |
|   Maximum number of COMMANDS to queue to the adapter  100,300,0               |
|   Maximum Data Transfer Window                    0x1000000,0x5000000,0x>     |
|   Operating mode                                  Primary Adapter             |
|   Adapter Cache                                   Default              +      |
|   Preferred HA Dual Initiator Operating mode      No Preference               |
|   Preferred HA Access State Setting               Preserve            +       |
|   Dual Initiator Configuration                    Default                     |
|   Serial Number                                   YL3027093770                |
|   World Wide ID                                   5005076c07040200            |
|   Remote HA Link Operational                      Yes                         |
|   Remote HA Serial Number                         07199172                    |
|   Remote HA World Wide ID                         5005076c07079300            |
|   Remote AWC Link Operational                                                 |
|   Remote AWC Serial Number                                                    |
|   Remote AWC World Wide ID                                                    |
|                                                                              |
| F1=Help            F2=Refresh          F3=Cancel          F4=List             |
| F5=Reset           F6=Command          F7=Edit            F8=Image            |
| F9=Shell           F10=Exit            Enter=Do                               |
+------------------------------------------------------------------------------+
```

```
+------------------------------------------------------------------------------+
|                        Change/Show SAS Controller                            |
|                                                                              |
| Type or select values in entry fields.                                       |
| Press Enter AFTER making all desired changes.                                |
|                                                                              |
|                                                   [Entry Fields]             |
|   SAS adapter                                     sissas0                     |
|   Description                                     PCI-X266 Ext Dual-x4 3>     |
|   Status                                          Available                   |
|   Location                                        03-08                       |
|   Maximum Number of Attached Devices              512                         |
|   Maximum number of COMMANDS to queue to the adapter  100,300,0               |
|   Maximum Data Transfer Window                    0x1000000,0x5000000,0x>     |
|   Operating mode                                  Secondary Adapter           |
|   Adapter Cache                                   Default              +      |
|   Preferred Dual HA Initiator Operating mode      No Preference               |
|   Preferred HA Access State Setting               Preserve            +       |
|   Dual Initiator Configuration                    Default                     |
|   Serial Number                                   YL3027199172                |
|   World Wide ID                                   5005076c07079300            |
|   Remote HA Link Operational                      Yes                         |
|   Remote HA Serial Number                         07093770                    |
|   Remote HA World Wide ID                         5005076c07040200            |
|   Remote AWC Link Operational                                                 |
|   Remote AWC Serial Number                                                    |
|   Remote AWC World Wide ID                                                    |
|                                                                              |
| F1=Help            F2=Refresh          F3=Cancel          F4=List             |
| F5=Reset           F6=Command          F7=Edit            F8=Image            |
| F9=Shell           F10=Exit            Enter=Do                               |
+------------------------------------------------------------------------------+
```

A summarized version of the link status information is available from the List SAS Disk Array
Configuration output from the IBM SAS Disk Array Manager:

```
+------------------------------------------------------------------------+
|                         COMMAND STATUS                                 |
|                                                                        |
| Command: OK          stdout: yes          stderr: no                   |
|                                                                        |
| Before command completion, additional instructions can appear below.   |
| [TOP]                                                                  |
| ----------------------------------------------------------------       |
| Name       Resource State       Description          Size              |
| ----------------------------------------------------------------       |
| sissas0    FFFFFFFF  Primary     PCI-X266 Ext Dual-x4 3 Gb SAS Adapter  |
|  sissas1   FFFFFFFF  HA Linked   Remote adapter SN  07199172           |
|                                                                        |
| hdisk2     00FF0000  Optimal     RAID 0 Array            69.7GB        |
|  pdisk4    00000400  Active      Array Member            69.7GB        |
|                                                                        |
| hdisk3     00FF0100  Optimal     RAID 10 Array           69.7GB        |
|  pdisk1    00000100  Active      Array Member            69.7GB        |
|  pdisk5    00000800  Active      Array Member            69.7GB        |
|                                                                        |
| [MORE...17]                                                            |
|                                                                        |
| F1=Help           F2=Refresh        F3=Cancel        F6=Command        |
| F8=Image          F9=Shell          F10=Exit         /=Find            |
| n=Find Next                                                            |
+------------------------------------------------------------------------+
```

```
+------------------------------------------------------------------------+
|                         COMMAND STATUS                                 |
|                                                                        |
| Command: OK          stdout: yes          stderr: no                   |
|                                                                        |
| Before command completion, additional instructions can appear below.   |
|                                                                        |
| [TOP]                                                                  |
| ----------------------------------------------------------------       |
| Name       Resource State       Description          Size              |
| ----------------------------------------------------------------       |
| sissas1    FFFFFFFF  Secondary   PCI-X266 Ext Dual-x4 3 Gb SAS Adapter  |
|  sissas0   FFFFFFFF  HA Linked   Remote adapter SN  07093770           |
|                                                                        |
| hdisk0     00FF0000  Optimal     RAID 0 Array            69.7GB        |
|  pdisk7    00000400  Unknown     Array Member            N/A           |
|                                                                        |
| hdisk1     00FF0100  Optimal     RAID 10 Array           69.7GB        |
|  pdisk4    00000100  Unknown     Array Member            N/A           |
|  pdisk12   00000800  Unknown     Array Member            N/A           |
|                                                                        |
| [MORE...17]                                                            |
|                                                                        |
| F1=Help           F2=Refresh        F3=Cancel        F6=Command        |
| F8=Image          F9=Shell          F10=Exit         /=Find            |
| n=Find Next                                                            |
+------------------------------------------------------------------------+
```

8. Optional: Set the Preferred Primary mode. You might want to configure one of the controllers in the HA single-system RAID configuration to be the Preferred Primary controller. This can be done for performance and usability reasons such as disk configuration changes. If neither controller is configured as the Preferred Primary controller, the controllers will default to primary or secondary through a negotiation process during boot.

Things to consider when determining the Preferred Primary controller:

- Because all disk array access must go through the primary controller, performance will be better for disk I/O operations from the system or partition containing the primary controller.
- All disk array configuration changes must be done on the system or partition containing the primary controller.

- Most disk service including error log analysis will be performed from the system or partition containing the primary controller. However, errors might also be presented by the secondary controller that might require actions on the system or partition containing the secondary controller.

  a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

  b. Select **Diagnostics and Recovery Options**.

  c. Select **Change/Show SAS RAID controller**.

  d. Select the desired IBM SAS controller.

  e. Select **Preferred Dual Initiator Operating mode** and choose **Primary Adapter**.

Installing an HA two-system RAID configuration

Use this procedure to help you to install an HA two-system RAID configuration.

To avoid problems during installation, follow the steps exactly as written.

Attention: Disk arrays can be created either before or after the HA RAID configuration is set up. See "Configuration and serviceability considerations for HA RAID configurations" on page 65 and "Functions requiring special attention in an HA two-system RAID configuration" on page 73 for important considerations.

1. Install and update the AIX SAS controller package on each system or partition. See "Controller software" on page 31 for more information.

   Attention: If you believe the controller might have been used in an **HA Two-System JBOD** configuration, do not attach cables in any HA RAID configuration. Disconnect all cables and change the controller's **Dual Initiator Configuration** to **Default** before using the controller in an HA RAID configuration.

2. Install the SAS controllers into the system or partition. Do not attach any cables to the SAS controllers at this time.

3. Update each controller to the latest SAS controller microcode from the code download Web site. See "Updating the SAS RAID controller microcode" on page 78.

4. To prevent errors while connecting the cables, unconfigure the SAS controller on each system or partition:

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Unconfigure an Available SAS RAID controller**.

   Note: In some environments, it might not be possible to unconfigure the controllers. To perform an error-free installation in these environments, perform a normal shutdown of the system or partition before you attach the cables.

5. Attach an appropriate cable from the shared disk expansion drawer to the same SAS connector on each controller. To see examples of how to cable HA configurations, see Serial-attached SCSI cable planning.

6. Configure the SAS controllers, or power on the system or partition if it was powered off earlier:

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Configure a Defined SAS RAID controller**.

7. View the HA RAID link status (to verify that the cabling and functioning of the controllers are correct) by using the Change/Show SAS Controller screen. Each system or partition should show an operational **Remote HA Link** to the other SAS controller in the remote system or partition.

a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
b. Select **Diagnostics and Recovery Options**.
c. Select **Change/Show SAS RAID controller**.
d. Select the IBM SAS controller that you want. The Change/Show SAS Controller screen displays information similar to the following examples:

```
+-------------------------------------------------------------------------------+
|                      Change/Show SAS Controller                               |
|                                                                               |
| Type or select values in entry fields.                                        |
| Press Enter AFTER making all desired changes.                                 |
|                                                                               |
|                                                   [Entry Fields]              |
|   SAS adapter                                     sissas0                      |
|   Description                                     PCI-X266 Ext Dual-x4 3>      |
|   Status                                          Available                    |
|   Location                                        0E-08                        |
|   Maximum Number of Attached Devices              512                          |
|   Maximum number of COMMANDS to queue to the adapter  100,300,0                |
|   Maximum Data Transfer Window                    0x1000000,0x5000000,0x>      |
|   Operating mode                                  Primary Adapter              |
|   Adapter cache                                   Default               +      |
|   Preferred HA Dual Initiator Operating mode      No Preference                |
|   Preferred HA Access State Setting               Preserve              +      |
|   Adapter cache                                   Default               +      |
|   Dual Initiator Configuration                    Default                      |
|   Serial Number                                   YL3027093770                 |
|   World Wide ID                                   5005076c07040200             |
|   Remote HA Link Operational                      Yes                          |
|   Remote HA Serial Number                         07199172                     |
|   Remote HA World Wide ID                         5005076c07079300             |
|   Remote AWC Link Operational                                                  |
|   Remote AWC Serial Number                                                     |
|   Remote AWC World Wide ID                                                     |
|                                                                               |
| F1=Help            F2=Refresh        F3=Cancel          F4=List               |
| F5=Reset           F6=Command        F7=Edit            F8=Image              |
| F9=Shell           F10=Exit          Enter=Do                                 |
+-------------------------------------------------------------------------------+
```

```
+--------------------------------------------------------------------------------+
|                         Change/Show SAS Controller                             |
|                                                                                |
| Type or select values in entry fields.                                         |
| Press Enter AFTER making all desired changes.                                  |
|                                                                                |
|                                                         [Entry Fields]         |
|   SAS adapter                                          sissas0                  |
|   Description                                          PCI-X266 Ext Dual-x4 3>  |
|   Status                                               Available               |
|   Location                                             03-08                   |
|   Maximum Number of Attached Devices                   512                     |
|   Maximum number of COMMANDS to queue to the adapter   100,300,0               |
|   Maximum Data Transfer Window                         0x1000000,0x5000000,0x>  |
|   Operating mode                                       Secondary Adapter       |
|   Adapter cache                                        Default              +   |
|   Preferred Dual HA Initiator Operating mode           No Preference           |
|   Preferred HA Access State Setting                    Preserve            +   |
|   Dual Initiator Configuration                         Default                 |
|   Serial Number                                        YL3027199172            |
|   World Wide ID                                        5005076c07079300        |
|   Remote HA Link Operational                           Yes                     |
|   Remote HA Serial Number                              07093770                |
|   Remote HA World Wide ID                              5005076c07040200        |
|   Remote AWC Link Operational                                                  |
|   Remote AWC Serial Number                                                     |
|   Remote AWC World Wide ID                                                     |
|                                                                                |
| F1=Help              F2=Refresh          F3=Cancel          F4=List            |
| F5=Reset             F6=Command          F7=Edit            F8=Image           |
| F9=Shell             F10=Exit            Enter=Do                              |
+--------------------------------------------------------------------------------+
```

A summarized version of the link status information is available from the List SAS Disk Array Configuration output from the IBM SAS Disk Array Manager:

```
+--------------------------------------------------------------------------------+
|                             COMMAND STATUS                                     |
|                                                                                |
| Command: OK            stdout: yes            stderr: no                        |
|                                                                                |
| Before command completion, additional instructions might appear below.         |
|                                                                                |
| [TOP]                                                                          |
| --------------------------------------------------------------------           |
| Name      Resource  State      Description            Size                     |
| --------------------------------------------------------------------           |
| sissas0   FFFFFFFF  Primary    PCI-X266 Ext Dual-x4 3 Gb SAS Adapter           |
|  tmscsi0  00FE0000  HA Linked  Remote adapter SN  07199172                     |
|                                                                                |
| hdisk2    00FF0000  Optimal    RAID 0 Array           69.7GB                   |
|  pdisk4   00000400  Active     Array Member           69.7GB                   |
|                                                                                |
| hdisk3    00FF0100  Optimal    RAID 10 Array          69.7GB                   |
|  pdisk1   00000100  Active     Array Member           69.7GB                   |
|  pdisk5   00000800  Active     Array Member           69.7GB                   |
|                                                                                |
| [MORE...17]                                                                    |
|                                                                                |
| F1=Help              F2=Refresh          F3=Cancel          F6=Command         |
| F8=Image             F9=Shell            F10=Exit           /=Find             |
| n=Find Next                                                                    |
+--------------------------------------------------------------------------------+
```

```
+-------------------------------------------------------------------+
|                         COMMAND STATUS                            |
|                                                                   |
| Command: OK            stdout: yes             stderr: no         |
|                                                                   |
| Before command completion, additional instructions might appear below. |
|                                                                   |
| [TOP]                                                             |
| ----------------------------------------------------------------- |
| Name       Resource  State      Description          Size         |
| ----------------------------------------------------------------- |
| sissas0    FFFFFFFF  Secondary  PCI-X266 Ext Dual-x4 3 Gb SAS Adapter |
|  tmscsi0   00FE0000  HA Linked   Remote adapter SN  07093770       |
|                                                                   |
| hdisk0     00FF0000  Optimal    RAID 0 Array         69.7GB        |
|  pdisk7    00000400  Unknown    Array Member           N/A         |
|                                                                   |
| hdisk1     00FF0100  Optimal    RAID 10 Array        69.7GB        |
|  pdisk4    00000100  Unknown    Array Member           N/A         |
|  pdisk12   00000800  Unknown    Array Member           N/A         |
|                                                                   |
| [MORE...17]                                                       |
|                                                                   |
| F1=Help            F2=Refresh         F3=Cancel         F6=Command |
| F8=Image           F9=Shell           F10=Exit          /=Find    |
| n=Find Next                                                       |
+-------------------------------------------------------------------+
```

8. Optional: Configure one of the controllers in the HA two-system RAID configuration to be the Preferred Primary controller. This might be done for performance and usability reasons such as disk configuration changes. If neither controller is configured as the Preferred Primary controller, the controllers will default to primary or secondary through a negotiation process during boot.

Things to consider when determining the Preferred Primary controller:

- Because all disk array access must go through the primary controller, performance will be better for disk I/O operations from the system or partition containing the primary controller.
- All disk array configuration changes must be done on the system or partition containing the primary controller.
- Most disk service including error log analysis will be performed from the system or partition containing the primary controller. However, errors might also be presented by the secondary controller that might require actions on the system or partition containing the secondary controller.

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
   b. Select **Diagnostics and Recovery Options**.
   c. Select **Change/Show SAS RAID controller**.
   d. Select the desired IBM SAS controller.
   e. Select **Preferred Dual Initiator Operating mode** and choose **Primary Adapter**.

Functions requiring special attention in an HA two-system RAID configuration

Manual intervention might be required on the system or partition containing secondary controller to get visibility to the new configuration.

Many configuration and serviceability functions need to be performed on the system or partition that contains a the primary controller. Any functions performed on the system or partition that contains a the primary controller might also require some manual intervention on the system or partition that contains a secondary controller to get visibility to the new configuration.

The following table lists some of the common functions and the required steps to perform on the secondary controller:

Table 14. Configuration steps for the secondary controller

Function performed on primary controller	Required configuration on secondary controller
Create pdisk (Format to 528 Byte Sectors)	If device was previously a JBOD hdisk: `rmdev –dl hdiskX` Then configure new pdisk device: `cfgmgr –l sissasX`
Delete pdisk (Format to 512 Byte Sectors)	Remove pdisk device: `rmdev –dl pdiskX` Then configure new hdisk device: `cfgmgr –l sissasX`
Create Disk Array	Configure new hdisk device: `cfgmgr –l sissasX`
Delete Disk Array	Remove array hdisk device: `rmdev –dl hdiskX`
Add disks to Disk Array	No configuration steps needed
Reconstruct Disk Array	No configuration steps needed
Create/Delete Hot Spare disk	No configuration steps needed
Add disk (Hot Plug Manager)	Configure new disk device: `cfgmgr –l sissasX`
Remove disk (Hot Plug Manager)	Remove disk device: `rmdev –dl pdiskX`
Reclaim Controller Cache Storage	No configuration steps needed

Installing an HA two-system JBOD configuration

Use this procedure to help you to install an HA two-system JBOD configuration.

To avoid problems during installation, follow the steps exactly as written.

Attention:

1. Consider using an HA RAID configuration rather than an HA JBOD configuration due to the increased redundancy, performance, and reliability provided by the RAID subsystem.
2. Both controllers must have the **Dual Initiator Configuration** option set to **JBOD HA Single Path** before being connected to the disk drives, all of the disk drives must be formatted to JBOD (512 bytes per sector) format, and the correct cabling must be used. Remove any devices from the disk expansion drawer that are not set to JBOD or reformat them to JBOD 512 bytes per sector.
3. It is normal for errors to be logged when updating SAS expander microcode due to the fact that there is only a single path to the expander in this configuration.

1. Install and update the AIX SAS controller package on each system or partition. See "Controller software" on page 31 for more information.
2. Install the SAS controllers into the system or partition. Do not attach any cables to the SAS controllers at this time.
3. Update each controller to the latest SAS controller microcode from the code download Web site. See "Updating the SAS RAID controller microcode" on page 78.
4. Set the Dual Initiator Configuration mode. Before connecting the AE cables to either controller, change the **Dual Initiator Configuration** to **JBOD HA Single Path** on each controller in each system.
   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
   b. Select **Diagnostics and Recovery Options**.
   c. Select **Change/Show SAS RAID controller**.
   d. Select the IBM SAS controller you want.
   e. Select **Dual Initiator Configuration** and choose **JBOD HA Single Path**.
5. To prevent errors while connecting the cables, unconfigure the SAS controller on each system or partition:

a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

b. Select **Diagnostics and Recovery Options**.

c. Select **Unconfigure an Available SAS RAID controller**.

   Note: In some environments, it might not be possible to unconfigure the controllers. To perform an error-free installation in these environments, perform a normal shutdown of the system or partition before you attach the cables.

6. Attach an AE cable from the shared disk expansion drawer to the same SAS connector on each controller. To see examples of how to cable the HA configurations, see Serial attached SCSI cable planning.

7. Configure the SAS controllers, or power on system or partition if powered off earlier:

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Configure a Defined SAS RAID controller**.

8. Verify that the cabling and functioning of the controllers are correct by using the Change/Show SAS Controller information screen. Each system or partition should show the SAS controller in an **Operating Mode** of **Standalone** and a **Dual Initiator Configuration** of **JBOD HA Single Path**.

   a. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.

   b. Select **Diagnostics and Recovery Options**.

   c. Select **Change/Show SAS RAID controller**.

   d. Select the IBM SAS controller that you want. The Change/Show SAS Controller screen displays information similar to the following example:

```
+------------------------------------------------------------------------------+
|                        Change/Show SAS Controller                            |
|                                                                              |
| Type or select values in entry fields.                                       |
| Press Enter AFTER making all desired changes.                                |
|                                                                              |
|                                                    [Entry Fields]            |
|   SAS adapter                                      sissas0                    |
|   Description                                      PCI-X266 Ext Dual-x4 3>    |
|   Status                                           Available                  |
|   Location                                         04-08                      |
|   Maximum Number of Attached Devices               512                        |
|   Maximum number of COMMANDS to queue to the adapter  100,300,0               |
|   Maximum Data Transfer Window                     0x1000000,0x5000000,0x>    |
|   Operating mode                                   Standalone Adapter        |
|   Adapter cache                                    Default              +     |
|   Preferred HA Dual Initiator Operating mode       No Preference        +     |
|   Preferred HA Access State Setting                Preserve             +     |
|   Dual Initiator Configuration                     JBOD HA Single Path  +     |
|   Serial Number                                    YL3087087597              |
|   World Wide ID                                    5005076c0703e900          |
|   Remote HA Link Operational                       No                        |
|   Remote HA Serial Number                                                     |
|   Remote HA World Wide ID                                                     |
|   Remote AWC Link Operational                                                 |
|   Remote AWC Serial Number                                                    |
|   Remote AWC World Wide ID                                                    |
|                                                                              |
| F1=Help            F2=Refresh        F3=Cancel          F4=List              |
| F5=Reset           F6=Command        F7=Edit            F8=Image             |
| F9=Shell           F10=Exit          Enter=Do                               |
+------------------------------------------------------------------------------+
```

SAS RAID controller maintenance

Ensure optimal performance of your controller by using these maintenance procedures.

To help avoid controller and disk array problems, use the following tips:

- Always perform a normal system shutdown before physically replacing or moving the RAID controller or members of disk arrays. A normal shutdown of the system will flush the controller's write cache and remove dependencies between the controller and the pdisks. Unconfiguring the controller by using the rmdev command (for example, rmdev -Rl sissas3) has the same effect as it would on a single controller when the system shutdown command is used.

  Note: pdisks that are a Failed member of a Degraded disk array can be replaced and the disk array reconstructed while the system continues to run. No system shutdown is required.

- You can physically move pdisks from one controller to another. However, if the pdisks are members of a disk array, be sure to move all the disks in the array as a group. Prior to attempting a disk movement, ensure that the disk array is not in a Degraded state because of a disk failure, and the controllers are unconfigured.

- When physically removing pdisks that are members of a disk array and there is no need to preserve data and no intent to use the disk array again, delete the disk array before removing the disks. This action avoids disk-array-related problems the next time that these disks are used.

- Always use the SCSI and SCSI RAID Hot Plug Manager to remove and replace a pdisk if performing a concurrent disk replacement. For instructions on how to remove and replace a disk, see "Replacing pdisks" on page 97.

- If a disk array is being used as a boot device and the system fails to boot because of a suspected disk array problem, boot using the Standalone Diagnostic media. Error Log Analysis, AIX error logs, the IBM SAS Disk Array Manager, and other tools are available on the Standalone Diagnostics media to help determine and resolve the problem with the disk array.

- Do not attempt to correct problems by swapping controllers and disks unless you are directed to do so by the service procedures. Use Error Log Analysis to determine what actions to perform, and when appropriate, follow the appropriate MAPs for problem determination. If multiple errors occur at approximately the same time, look at them as a whole to determine if there is a common cause. For additional information regarding problem determination, see Problem Determination and Recovery.

- Do not confuse the cache directory card, which is a small rectangular card with round, button-shaped batteries, for a removable cache card. The nonvolatile write cache memory is integrated into the controller. The write cache memory itself is battery-backed by the large, rechargeable cache battery pack. The cache directory card contains only a secondary copy of the write cache directory and no cache data. Do not remove this card except under very specific recovery cases as described in the Maintenance Analysis Procedures (MAPs).

- Do not unplug or exchange a cache battery pack without following the procedures as outlined in this section or in the MAPs. Failure to follow these procedures might result in data loss.

- When invoking diagnostic routines for a controller, use the Problem Determination (PD) mode instead of System Verification (SV) mode unless there is a specific reason to use SV mode (for example, you were directed to run SV mode by a MAP).

- After diagnostic routines for a controller are run in SV mode, run diagnostics in PD mode to ensure that new errors are analyzed. These actions should be performed especially when using Standalone Diagnostic media.

Updating the SAS RAID controller microcode

Determine if you need to update your SAS RAID controller microcode, then download and install the updates.

To determine if an update is needed for your controller, follow the directions at Microcode downloads. If updates are needed, download instructions are also located at that Web address.

To install the update to a controller, do the following steps:

1. Type smit and press Enter.
2. Select **Devices**.
3. Select **Disk Array**.
4. Select **IBM SAS Disk Array**.
5. Select **Download Microcode to a SAS Controller**.
6. Select the controller that you want.
7. Follow the instructions to complete the update.

Changing pdisks to hdisks

To change array candidate pdisks (528 bytes per sector) to standalone hdisks (512 bytes/sector), you must delete and format the pdisks.

Note: You cannot change pdisks that are members of a disk array or are hot spares to standalone hdisks.

To change the pdisks to standalone hdisks, do the following:

1. Navigate to the IBM SAS Disk Array Manager by using the steps in "Using the Disk Array Manager" on page 33.
2. Select **Change/Show SAS pdisk Status**.
3. Select **Delete an Array Candidate pdisk and Format to 512 Byte Sectors**.
4. Select the appropriate SAS RAID controller.
5. Select the 528 bytes/sector pdisks to be formatted to 512 bytes per sector standalone hdisks.

   Attention: Continuing with this option will format the disks. All data on the disks will be lost. When the format is completed, the pdisk will be deleted and replaced by an hdisk.

Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters

Learn about the rechargeable battery maintenance tasks that include displaying rechargeable battery information, forcing a rechargeable battery error, and replacing the rechargeable cache battery pack.

Attention: Use these procedures only if directed from an isolation procedure or a maintenance analysis procedure (MAP).

The following topics provides links to the information about maintaining the rechargeable battery on the SAS adapters for the systems or logical partition running on the different operating systems.

For information about maintaining the rechargeable battery using the Linux operating system, see Rechargeable battery maintenance.

For information about maintaining the rechargeable battery using the IBM i operating system, see Rechargeable battery maintenance.

Displaying rechargeable battery information

Use this procedure to display information about the controller's rechargeable battery.

1. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Controller Rechargeable Battery Maintenance**.
4. Select **Display Controller Rechargeable Battery Information**.
5. Select the controller. The screen displayed will look similar to the following Command Status screen.

```
+------------------------------------------------------------------------------+
|                            COMMAND STATUS                                     |
|                                                                              |
|Command: OK           stdout: yes           stderr: no                        |
|                                                                              |
|Before command completion, additional instructions may appear below.          |
|                                                                              |
|RAID Adapter  . . . . . . . . . . . . . : sissas0                             |
|Battery Type  . . . . . . . . . . . . . : Lithium Ion (LiIon)                 |
|Battery State . . . . . . . . . . . . . : No battery warning/error            |
|Power-on time (days)  . . . . . . . . . : 139                                 |
|Adjusted power-on time (days) . . . . . : 152                                 |
|Estimated time to warning (days)  . . . : 751                                 |
|Estimated time to error (days)  . . . . : 834                                 |
|Concurrently maintainable battery pack. : Yes                                 |
|Battery pack can be safely replaced . . : No                                  |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|                                                                              |
|F1=Help            F2=Refresh         F3=Cancel          F6=Command           |
|F8=Image           F9=Shell           F10=Exit           /=Find               |
|n=Find Next                                                                   |
+------------------------------------------------------------------------------+
```

The following are the fields displayed on the rechargeable battery information screen:

RAID Adapter

The name of the selected controller.

Battery Type

The type of rechargeable cache battery pack.

Battery State

Indicates if an error condition currently exists related to the rechargeable cache battery pack. The possible values for this field are:

No battery warning/error

No warning or error condition currently exists.

Warning condition

A warning condition currently exists and an error has been logged.

Error condition

An error condition currently exists and an error has been logged.

Unknown

Information is not available to determine whether a warning or error condition currently exists.

Power-on time (days)

Indicates the raw power-on time, in units of days, of the rechargeable cache battery pack.

Adjusted power-on time (days)

Indicates the adjusted (prorated) power-on time, in units of days, of the rechargeable cache battery pack.

Note: Some rechargeable cache battery packs are negatively affected by higher temperatures and thus are prorated based on the amount of time that they spend at various ambient temperatures.

Estimated time to warning (days)

Estimated time, in units of days, until a message is issued indicating that the replacement of the rechargeable cache battery pack should be scheduled.

Estimated time to error (days)

Estimated time, in units of days, until an error is reported indicating that the rechargeable cache battery pack must be replaced.

Concurrently maintainable battery pack

Indicates if the rechargeable cache battery pack can be replaced while the controller continues to operate.

Battery pack can be safely replaced

Indicates if the controller's write cache has been disabled and the rechargeable cache battery pack can be safely replaced.

Error state

The cache battery pack should be in an error state before you replace it.

To prevent possible data loss, ensure that the cache battery pack is in an error state before replacing it. This will ensure all cache data is written to disk before battery replacement. Forcing the battery error will result in the following:

- The system logs an error.
- Data caching becomes disabled on the selected controller.
- System performance could become significantly degraded until the cache battery pack is replaced on the selected controller.
- The **Battery pack can be safely replaced** field on the controller rechargeable battery information screen indicates Yes.

- Cache data present LED stops flashing. See the feature descriptions and the figures in the Rechargeable battery maintenance section to determine if your adapter has a cache data present LED and the location of the LED.

This error state requires replacement of the cache battery. Ensure that you have the correct type and quantity of cache battery packs to do the replacement. To resume normal operations, replace the cache battery pack.

The cache battery pack for the 572F storage I/O adapter and the 575C auxiliary cache adapter is contained in a single battery field replacement unit (FRU) that is physically located on the 575C auxiliary cache adapter. The functions of forcing a battery pack error and starting the adapter cache on either adapter in the card set results in the same function automatically being performed on the other adapter in the card set.

Forcing a rechargeable battery error

Use this procedure to place the controller's rechargeable battery into an error state.

1. Navigate to the IBM SAS Disk Array Manager by using the steps found in "Using the Disk Array Manager" on page 33.
2. Select **Diagnostics and Recovery Options**.
3. Select **Controller Rechargeable Battery Maintenance**.
4. Select **Force Controller Rechargeable Battery Error**.
5. Select the controller whose battery you want to replace.

   Note: Using this option places the battery into the error state, which requires it to be replaced.

6. Press Enter.
7. Determine that it is safe to replace the cache battery pack. Refer to "Displaying rechargeable battery information" on page 79. When **Yes** is displayed next to **Battery pack can be safely replaced**, it is safe to replace the cache battery pack. You might need to redisplay the rechargeable battery information multiple times as it could take several minutes before it is safe to replace the cache battery pack.
8. Verify that the cache data present light emitting diode (LED) is no longer flashing before replacing the cache battery pack as described in Replacing a battery pack. See the feature comparison tables for PCIe and PCI-X cards and the figures in the replacement procedures in this section to determine if your adapter has a cache data present LED and the LED's location.

Replacing a battery pack

Follow these guidelines before replacing your battery pack.

Note: When replacing the cache battery pack, the battery must be disconnected for at least 60 seconds before connecting the new battery. This duration is the minimum amount of time needed for the card to recognize that the battery has been replaced.

Note: The battery is a lithium ion battery. To avoid possible explosion, do not burn. Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call.

Attention: To prevent data loss, if the cache battery pack is not already in the error state, follow the steps described in Forcing a rechargeable battery error before proceeding. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature descriptions and the figures in the following sections to determine if your adapter has a cache data present LED and the location of the LED.

Attention: Static electricity can damage this device and your system unit. To avoid damage, keep this device in its antistatic protective bag until you are ready to install it. To reduce the possibility of electrostatic discharge, read the following precautions:

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its antistatic package, touch it to an unpainted metal part of the system unit for at least 2 seconds. (This duration drains static electricity from the package and from your body.)
- Remove the device from its package and install it directly into your system unit without setting it down. If it is necessary to set the device down, place it on its static-protective package. (If your device is a controller, place it component-side up.) Do not place the device on your system unit cover or on a metal table.
- Take additional care when handling devices during cold weather, as heating reduces indoor humidity and increases static electricity.

Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters

Learn about the rechargeable battery maintenance tasks that include displaying rechargeable battery information, forcing a rechargeable battery error, and replacing the rechargeable cache battery pack.

Attention: Use these procedures only if directed from an isolation procedure or a maintenance analysis procedure (MAP).

The following topics provide information about maintaining the rechargeable battery on the SAS adapters for the systems or logical partition running on the different operating systems.

For information about maintaining the rechargeable battery for systems running on the AIX operating system, see Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters.

For information about maintaining the rechargeable battery for systems running on the Linux operating system, see Rechargeable battery maintenance.

For information about maintaining the rechargeable battery for systems running on the IBM i operating system, see Rechargeable battery maintenance.

Replacing a 572B nonconcurrent maintainable battery pack

Use this procedure to replace the nonconcurrent maintainable battery pack on adapter type CCIN 572B.

Attention: Before continuing with this procedure, determine that it is safe to replace the cache battery pack. See Displaying rechargeable battery information. It is safe to replace the cache battery pack when **Yes** is displayed next to **Battery pack can be safely replaced**.

Complete the following steps to replace a nonconcurrent maintainable battery pack.

1. Remove the controller from the system. See your system documentation for instructions.
2. Place the controller on a surface that is electrostatic-discharge protected.
3. Unplug the battery connector **(B)** from its connector on the adapter, squeezing the retaining latch while gently pulling on the plug. The plug connects to the board in only one way, so it cannot be inserted incorrectly during the replacement procedure.

    Note: Ensure that the cache battery pack is disconnected for at least 60 seconds before connecting the new battery. This duration is the minimum amount of time needed for the adapter to recognize that

the battery has been replaced.
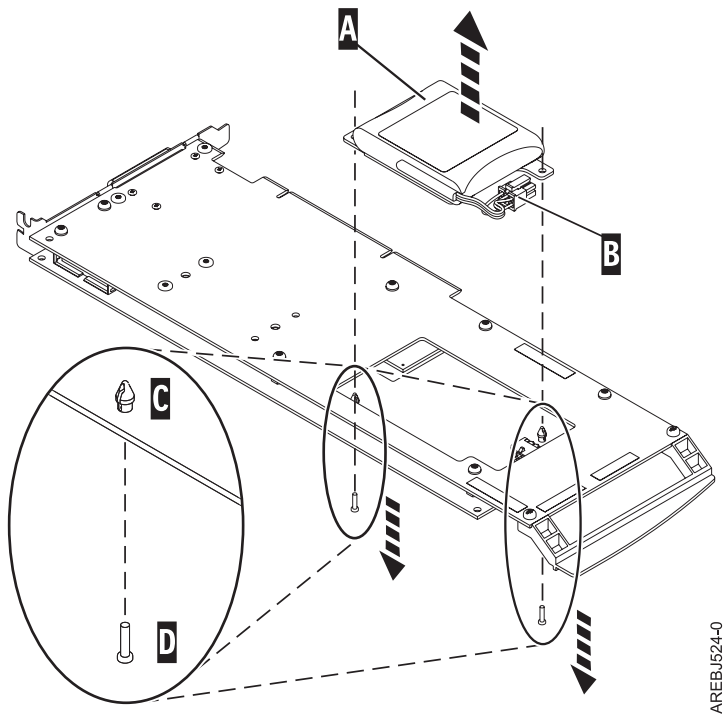
Figure 29. Removing the cache battery

   (A) Cache battery pack
   (B) Battery connector
   (C) Plastic rivet
   (D) Plastic pin

4. Locate the two plastic rivets **(C)** that hold the cache battery pack in place. From the back of the adapter, remove the two pins **(D)** that are inserted inside of the rivets.

5. Release the rivets **(C)** that secure the battery assembly to the adapter. Press the rivets through the back of the adapter and remove the battery pack **(A)** from the adapter. If the rivets **(C)** cannot be pressed through the back of the adapter, follow these steps to press out the rivets with a ballpoint pen:

   a. Locate a retractable ballpoint pen.

      Note: A medium-sized retractable ballpoint pen is preferred, or an equivalent item with a small opening can be used. The small opening must be large enough so that the pen (or equivalent) can go around the tip of the rivet, but small enough that it does not slide over the rivet and contact the battery assembly bracket.

   b. Slide the card off the edge of the work area enough so rivet **(C)** can be pressed out of the back of the adapter.

   c. Hold the pen with the ballpoint retracted, place the pen on top of rivet **(C)**, and gently press straight down until rivet **(C)** presses out.

   d. Repeat steps 5b and 5c for the other rivet **(C)**.

   e. Remove the cache battery pack **(A)** from the adapter.

   f. Turn the adapter over and press the rivets **(C)** back into the adapter.

6. Install the new battery pack. **(A)** onto the press rivets **(C)** of the adapter.

7. Reinsert the pins **(D)** into the rivets from the back of the adapter.

8. Connect the cache battery pack connector **(B)** to the adapter. The plug connects to the adapter in only one way, so it cannot be inserted incorrectly.

9. Reinstall the adapter.

Replacing a 572F/575C card set concurrent maintainable battery pack

Use this procedure to replace the concurrent maintainable battery pack on adapter type CCIN 572F/575C card set.

Attention: Before continuing with this procedure, determine that it is safe to replace the cache battery pack. See "Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters" on page 82. It is safe to replace the cache battery pack when **Yes** is displayed next to **Battery pack can be safely replaced**. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature comparison tables for PCIe and PCI-X cards for the LED details and its location.

Complete the following steps to replace a 572F/575C concurrent maintainable battery pack.

1. Using the following illustration to locate the battery components, locate the metal cover **(A)** that holds the battery pack. Pull out on the push-rivet **(B)** to release the metal cover **(A)**.
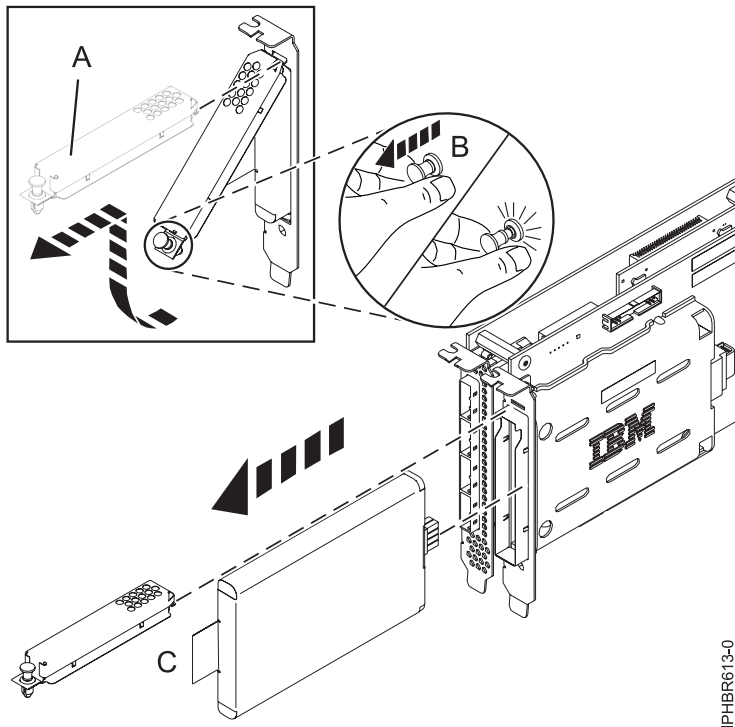
Figure 30. Replacing the 572F/575C cache battery

     (A) Metal cover

     (B) Push-rivet

     (C) Tab

2. Remove the battery unit by pulling on tab **(C)**.

     Note: Ensure that the cache battery pack is disconnected for at least 60 seconds before connecting the new battery. This duration is the minimum amount of time needed for the card to recognize that the battery has been replaced.

3. Install the new cache battery pack by reversing this procedure. Ensure that the replacement cache battery pack is fully seated.
4. Restart the adapter's write cache by doing the following:
    a. Return to the **Work with Resources containing Cache Battery Packs display** and select the **Start IOA cache**. Press Enter.
    b. Ensure that you get the message `Cache was started`.

Replacing a 574E concurrent maintainable battery pack

Use this procedure to replace the concurrent maintainable battery pack on adapter type CCIN 574E.

Attention: Before continuing with this procedure, determine that it is safe to replace the cache battery pack. See "Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters" on page 82. It is safe to replace the cache battery pack when **Yes** is displayed next to **Battery pack can be safely replaced**. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature comparison tables for PCIe and PCI-X cards and the following figures to determine whether your adapter has a cache data present LED and its location.

Complete the following steps to replace a 574E concurrent maintainable battery pack.

1. Using the following illustration to locate the battery components, verify that the cache data present LED **(C)** is not flashing. If it is flashing, do not continue; return to Forcing a rechargeable battery error.
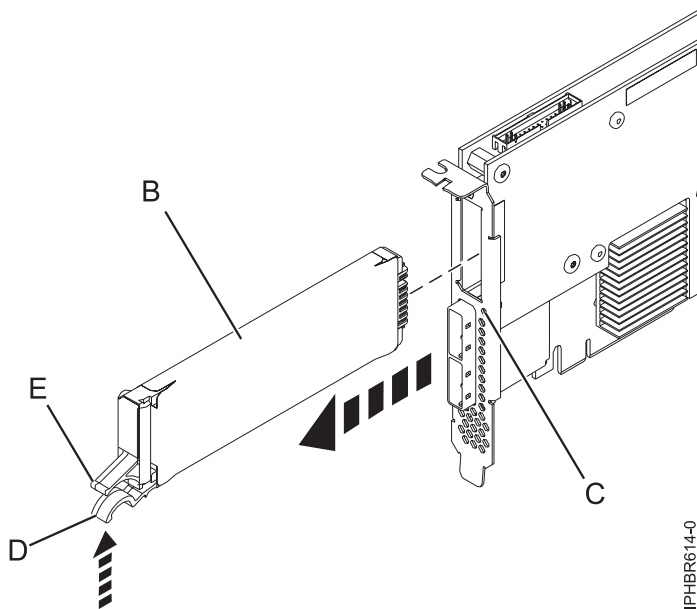
Figure 31. Replacing the 574E cache battery

      (B) Cache battery pack

      (C) Cache data present LED

      (D) Cache battery tab

      (E) Cache battery tab

2. Squeeze tab **(D)** against tab **(E)** to disengage the battery retaining tab, pull out the cache battery pack **(B)**, and remove it from the controller.

Important: Use caution when squeezing tabs because the plastic parts can be fragile.

Note: Ensure that the cache battery pack is disconnected for at least 60 seconds before connecting the new battery. This duration is the minimum amount of time needed for the card to recognize that the battery has been replaced.

3. Install the new cache battery pack by reversing this procedure. Ensure that the replacement cache battery back is fully seated.

4. Restart the adapter's write cache by doing the following:

   a. Return to the **Work with Resources containing Cache Battery Packs display** and select the **Start IOA cache**. Press Enter.

   b. Ensure that you get the message `Cache was started`.

Replacing a 57B7 concurrent maintainable battery pack

Use this procedure to replace the concurrent maintainable battery pack on adapter type CCIN 57B7.

Attention: Before continuing with this procedure, determine that it is safe to replace the cache battery pack, see "Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters" on page 82. It is safe to replace the cache battery pack when **Yes** is displayed next to **Battery pack can be safely replaced**. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature comparison tables for PCIe and PCI-X cards and the following figures to determine whether your adapter has a cache data present LED and its location.

Complete the following steps to replace a 57B7 concurrent maintainable battery pack.

1. Using the following illustration to locate the battery components, verify that the cache data present LED **(C)** is not flashing. If it is flashing, do not continue; return to "Maintaining the rechargeable battery on the 57B7, 57CF, 574E, and 572F/575C SAS adapters" on page 82.
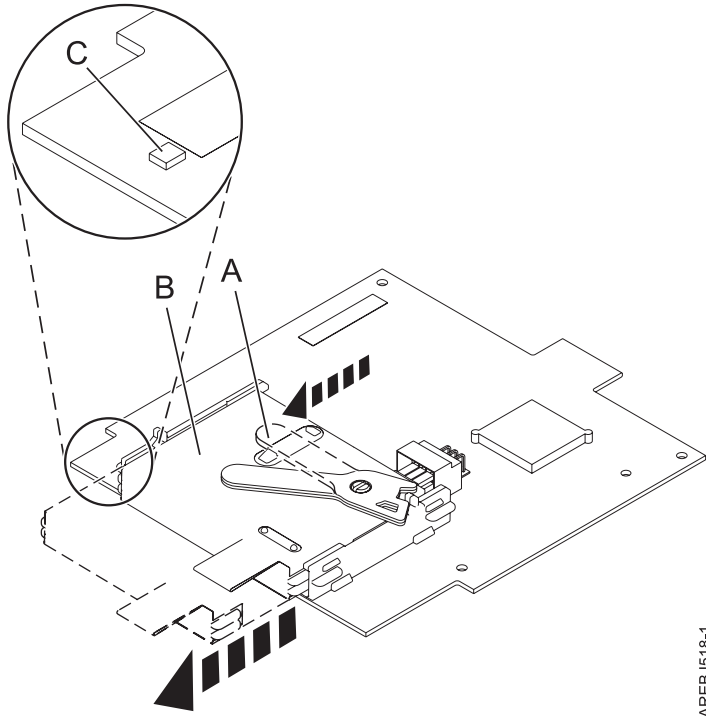
(A) Cache battery lever
(B) Cache battery pack
(C) Cache present LED

Figure 32. Removing the 57B7 cache battery

2. Move the cache battery lever **(A)** away from the connector to disengage the battery from the connector.

   Note: Hold the RAID auxiliary cache card with one hand to ensure it stays in the connector while using the other hand to move the lever and remove the battery from the card.

3. Continue to slide the cache battery pack out of the mounting guides and remove it from the controller.

   Note: Ensure that the cache battery pack is disconnected for at least 60 seconds before connecting the new battery. This duration is the minimum amount of time needed for the card to recognize that the battery has been replaced.

4. Using the following illustration to locate the battery components, move the lever to the unlatched position (away from the connector).
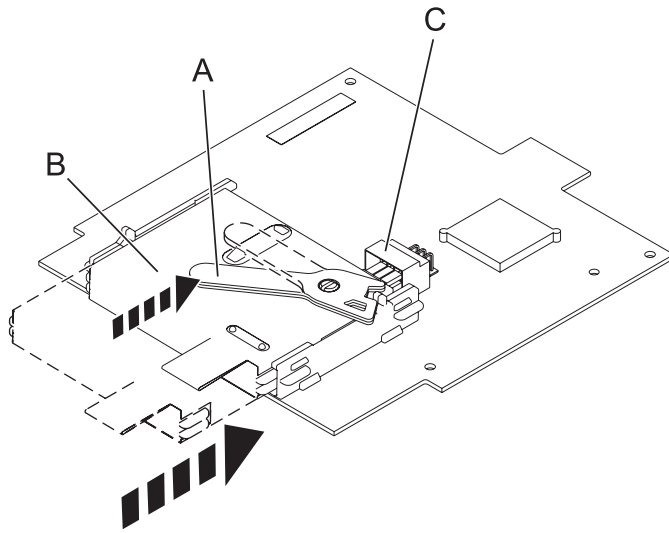
Figure 33. Replacing the 57B7 cache battery

> **(A)** Cache battery lever
>
> **(B)** Cache battery pack
>
> **(C)** Cache battery connector

5. Slide the new cache battery pack into the mounting guides on the controller until it is seated in the battery connector.

6. After the battery is seated in the connector, move the lever to the latched position to fully seat the battery into the connector.

7. Restart the adapter's write cache by doing the following:

    a. Navigate to the **IBM SAS Disk Array Manager** by using the steps in Using the Disk Array Manager.

    b. Select **Diagnostics and Recovery** Option.

    c. Select **Controller Rechargeable Battery Maintenance**.

    d. Select **Start Adapter Cache**.

    e. Select the controller with the battery you just replaced.

    f. Press **Enter**.

Replacing a 57CF cache battery pack

Learn how to replace the 57CF cache battery pack.

To replace the 57CF cache battery pack, see Removing and replacing the 9117-MMB, 9117-MMC, 9179-MHB, or 9179-MHC 175 MB cache RAID - dual IOA enablement card cache battery pack.

Removing and replacing a cache battery pack

Use this procedure to replace the cache battery pack on a battery card.

Identify the system that you will be working on by using the identify the system process to turn on the system locate (blue) indicator. For more information, see Control panel LEDs.

Attention: Before continuing with this procedures, determine that it is safe to replace the cache battery pack. See Displaying rechargeable battery information. It is safe to replace the cache battery pack when **Yes** is displayed next to **Battery pack can be safely replaced**.

Attention: To maintain system availability and prevent possible data loss, it is important to understand that these features have implications on the serial-attached SCSI (SAS) configuration and data accessibility of the system. Review the SAS subsystem topic to understand the various SAS configuration and service considerations.

Before servicing or installing any features, review the I/O configurations for each logical partition on your system. It is important to understand the differences between the various configurations and the resulting service considerations. In addition, consider possible impacts to the following areas:

- Logical partitions and their I/O adapter assignments
- RAID array configurations
- Physical disk locations
- Path to your boot device

Complete the following steps to replace a nonconcurrent maintainable battery pack:

1. Remove the controller from the system. For more information, see Removing the 8202-E4B, 8202-E4C, 8202-E4D, 8205-E6B, 8205-E6C, or 8205-E6D RAID/cache storage controller.
2. Place the controller on a surface that is electrostatic-discharge protected.
3. Unplug the battery connector **(A)** from its connector on the adapter, squeezing the retaining latch while gently pulling on the plug. The plug connects to the board in only one way; therefore, it cannot be inserted incorrectly during the replacement procedure.

    Note: Ensure that the cache battery pack is disconnected for at least 60 seconds before connecting the new battery. This is the minimum amount of time needed for the adapter to recognize that the battery has been replaced.
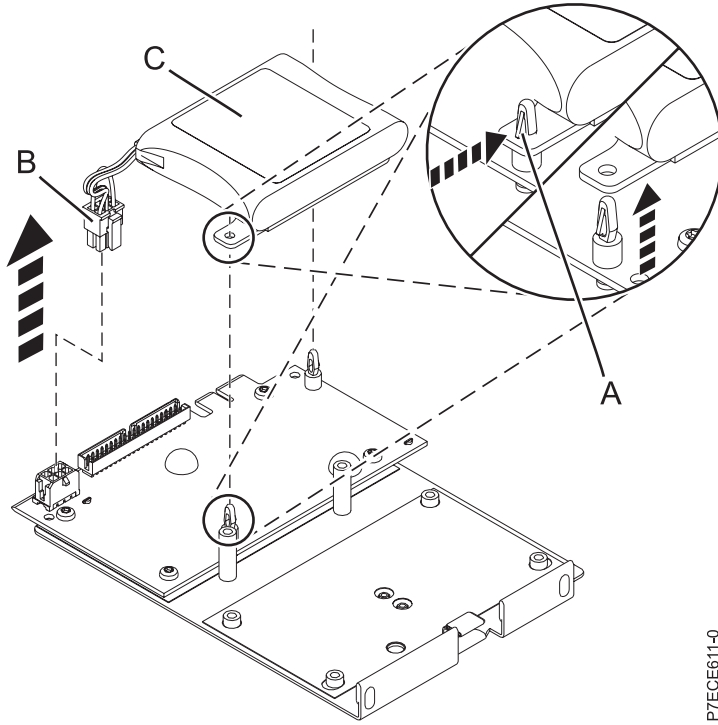
Figure 34. Removing the cache battery

    (A) Standoff tab

    (B) Battery connector

    (C) Cache battery pack

4. Remove the battery assembly:
   - Remove the mounting plate from the standoffs, one standoff at a time
   - Push in the standoff retaining tab and pull up on the mounting tab until the standoff is released through the hole in the mounting tab. Repeat this step for the second standoff.

   Note:
   - The battery is mounted on a black plastic plate with two tabs, secured by white plastic standoffs with the retaining tabs.
   - If the retaining tab is difficult to push in, turn the white standoff so its retaining tab faces away from the battery pack.

5. Install the battery on to the posts until the latches click into place.
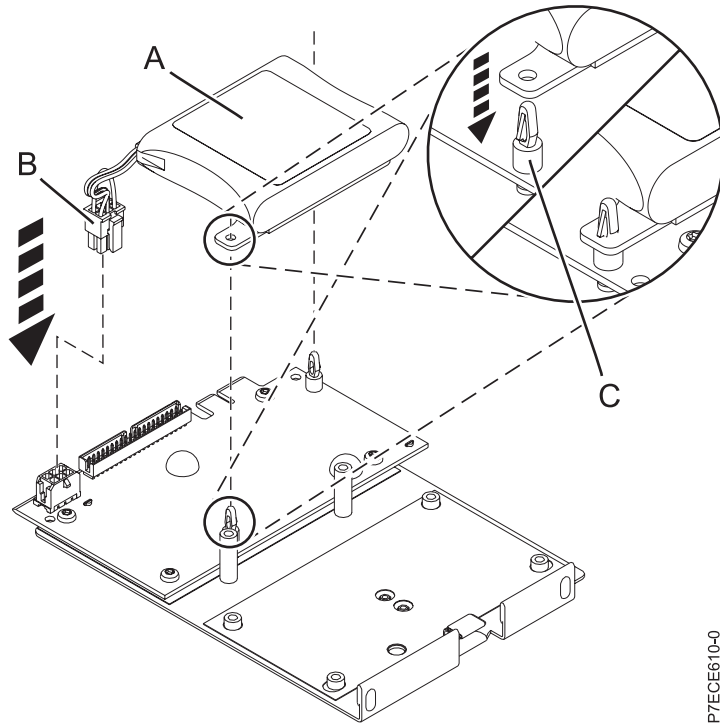
Figure 35. Replacing the cache battery

      (A) Cache battery pack

      (B) Battery connector

      (C) Standoff tab

6. Reinsert the pins into the rivets from the rear of the adapter.

7. Connect the cache battery pack connector **(B)** to the adapter. The plug connects to the adapter in only one way; therefore it cannot be inserted incorrectly.

8. Reinstall the adapter and restart the cache. For more information, see the following procedures:

   - Removing and replacing the cache battery card.
   - Removing the 8202-E4B, 8202-E4C, 8202-E4D, 8205-E6B, 8205-E6C, or 8205-E6D RAID/cache storage controller.

Separating the 572F/575C card set and moving the cache directory card

When the maintenance procedures direct you to separate the 572F/575C card set and move the cache directory card on a 572F controller for recovery purposes, carefully follow this procedure.

Important: To avoid loss of cache data, do not remove the cache battery during this procedure.

Notes:

- This procedure should only be performed if directed from an isolation procedure or a maintenance analysis procedure (MAP).
- If you are removing the adapter from a double-wide cassette, go to the procedures in your system unit's service information for removing a double-wide adapter from a double-wide cassette.

Attention: All cards are sensitive to electrostatic discharge. See Handling static-sensitive devices before beginning this procedure.

To separate the 572F/575C card set and move the cache directory card, complete the following steps.

1. Label both sides of the card before separating them.

2. Place the 572F/575C card set adapter on an ESD protective surface and orient it as shown in Figure 36.
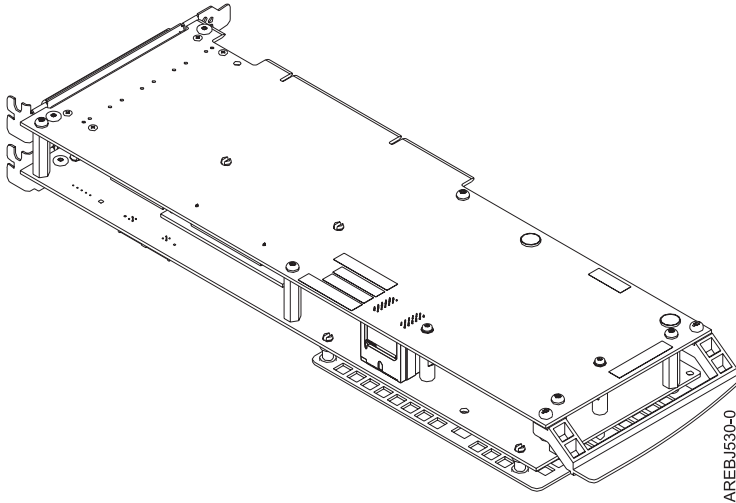
Figure 36. 572F/575C card set adapter

3. To prevent possible card damage, loosen all five retaining screws **C** before removing any of them. After all five retaining screws have been loosened, remove the screws **C** from the 572F storage adapter.

   Important: Failure to loosen all five retaining screws prior to removing any of the screws can result in damage to the card.
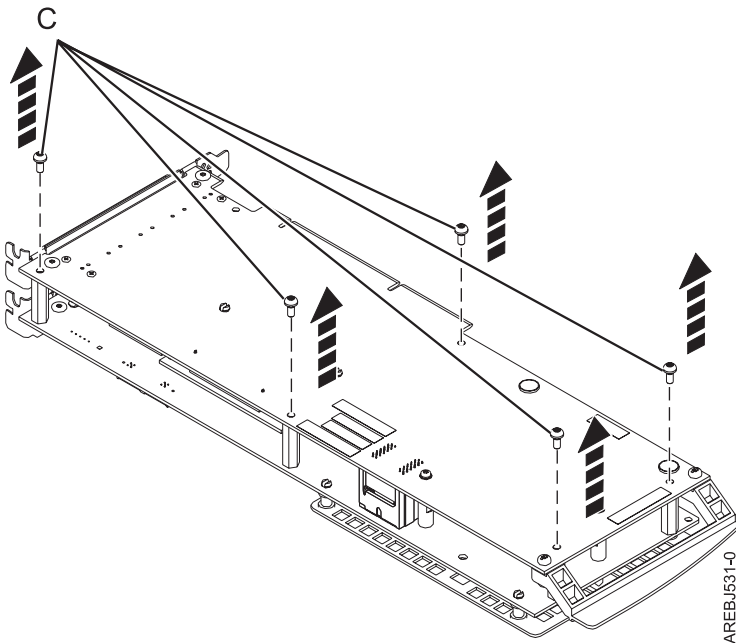
Figure 37. Location of screws on the 572F/575C card set adapter

C Screws

4. Grasp the 572F and 575C adapters close to the interconnect connector $\boxed{A}$, as shown in the following figure, and carefully pull the connector apart; then, set the adapters on the ESD protective surface.
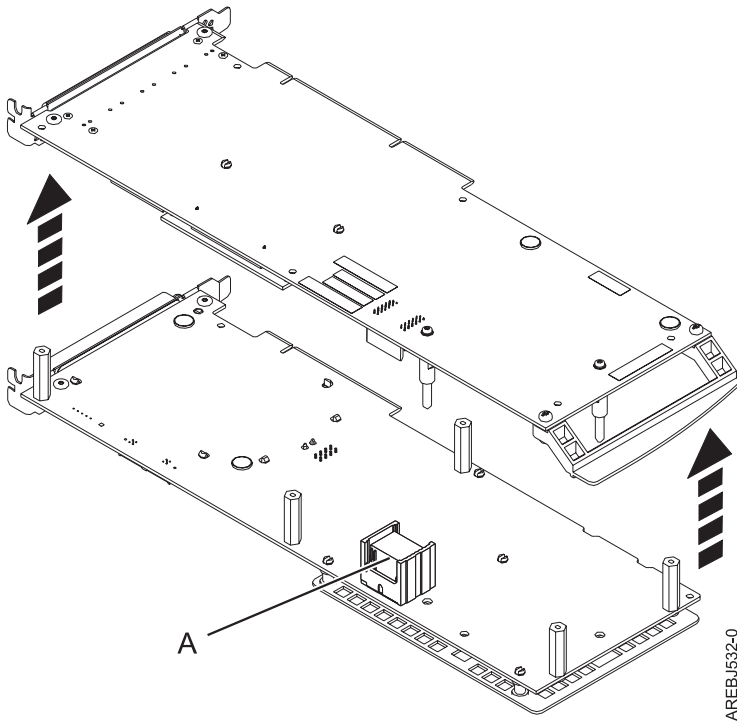
Figure 38. Location of interconnect connector on the 572F/575C card set adapter

$\boxed{A}$ Interconnect connector

5. Turn the 572F storage adapter over so the components are facing up. Locate the cache directory card $\boxed{D}$ on the 572F storage adapter. The cache directory card is the small rectangular card mounted on the I/O card.
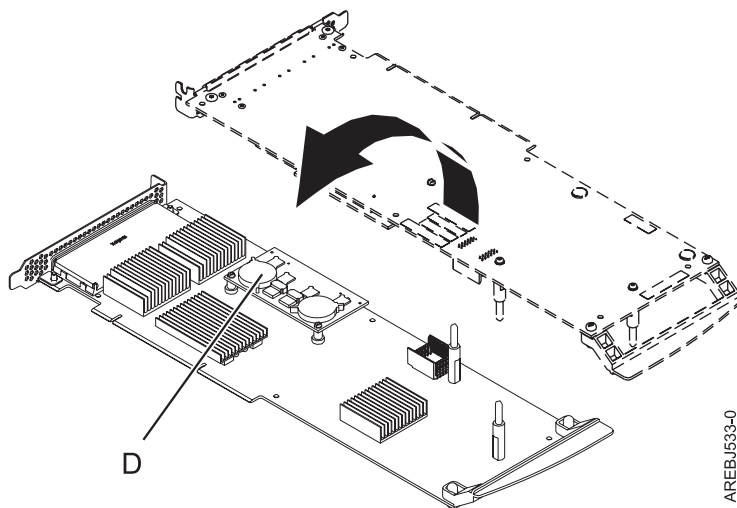
Figure 39. Cache directory card

$\boxed{D}$ Cache directory card

6. Unseat the connector on the cache directory card by wiggling the two corners that are farthest from the mounting pegs. To disengage the mounting pegs, pivot the cache directory card back over the

mounting pegs.
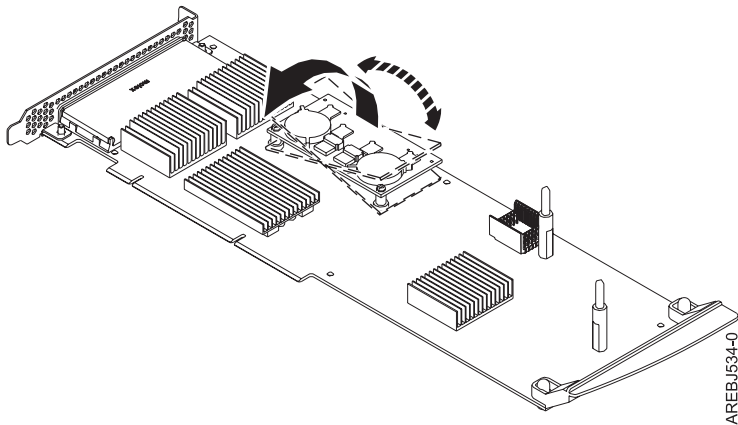
Figure 40. Unseating the connector

7. Move the cache directory card to the replacement 572F storage adapter and seat it on the connector and mounting pegs.

8. To reassemble the cards, perform the preceding procedure in reverse order. When connecting the two adapters together, carefully align guide pins **B** on each side of the interconnect connector **A** . After the connector is seated correctly, apply pressure to completely squeeze the connector together. To prevent possible card damage, insert all five screws **C** before tightening any of them.
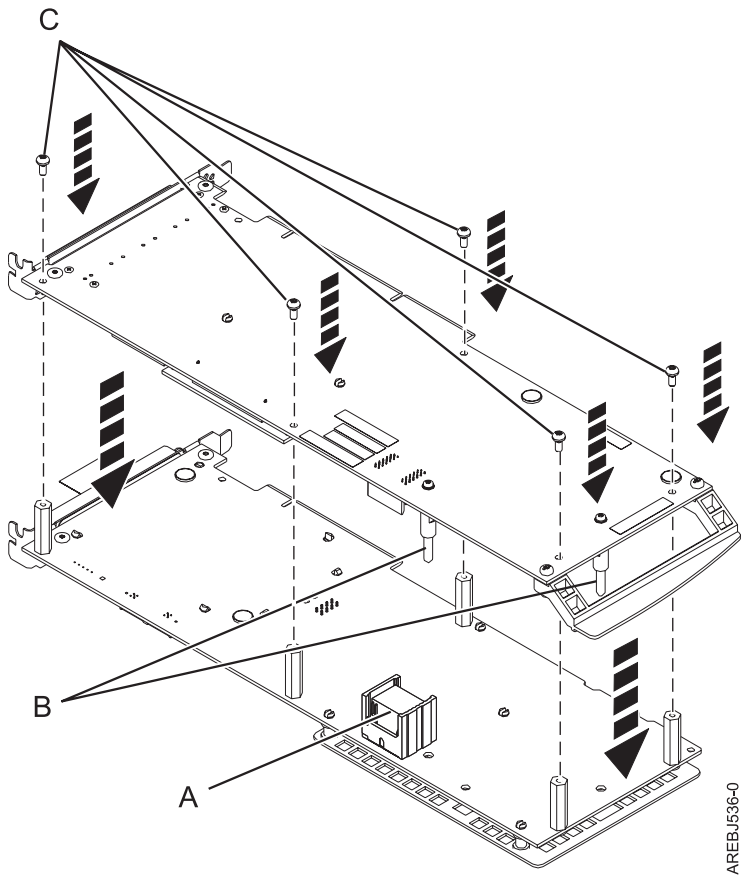
Figure 41. Reassembling the cards

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A Interconnect connector
B Guide pins
C Screws

9. Cassette installations only: If you are installing the 572F/575C card set adapter into a cassette, perform the following steps:

   a. Remove the adapter handle **B** as shown in Figure 42.
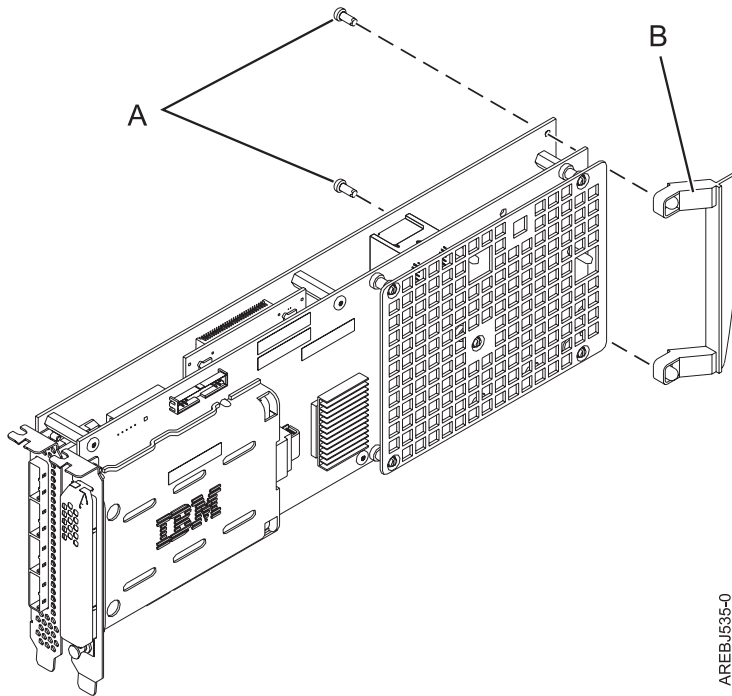
Figure 42. Cassette adapter handle attachment

A Push-rivets
B Adapter handle

   b. If you removed the double-wide PCI adapter from a cassette in the beginning of this procedure, reinstall the adapter into the double-wide cassette to complete the installation. See the procedures in your system unit's service information for installing a double-wide adapter in a double-wide cassette.

10. Return to the procedure that sent you here. **This ends this procedure.**

Replacing the cache directory card

When the maintenance procedures direct you to replace the cache directory card, carefully follow this procedure.

Attention: Perform this procedure only if you are directed from an isolation procedure or a maintenance analysis procedure (MAP).

Attention: Static electricity can damage this device and your system unit. To avoid damage, keep this device in its antistatic protective bag until you are ready to install it. To reduce the possibility of electrostatic discharge, read the following precautions:

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its antistatic package, touch it to an unpainted metal part of the system unit for at least two seconds. (This drains static electricity from the package and from your body.)
- Remove the device from its package and install it directly into your system unit without setting it down. If it is necessary to set the device down, place it on its static-protective package. (If your device is a controller, place it component-side up.) Do not place the device on your system unit cover or on a metal table.
- Take additional care when handling devices during cold weather, as heating reduces indoor humidity and increases static electricity.

To replace the cache directory card, complete the following steps:

1. Remove the controller using the remove procedures for the model or expansion unit on which you are working.
2. Locate the cache directory card **A** .
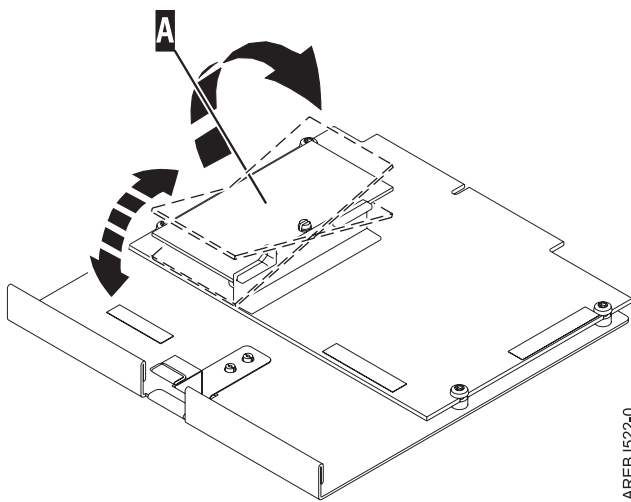
3. Unseat the connector on the cache directory card by wiggling the two corners over the connector, using a rocking motion. Then lift the cache directory card off the connector and out of the guides on the plastic support rail.
4. Install the replacement cache directory card **A** by inserting it into the guides on the plastic support rail and then seating it on the connector.
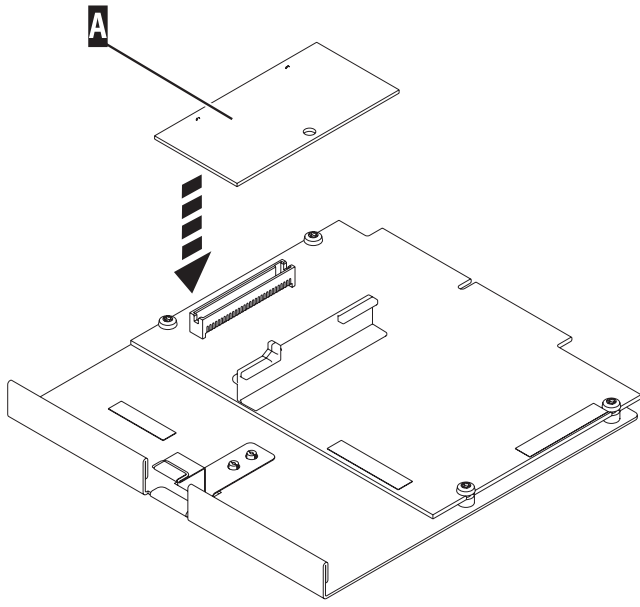
AREBJ523-0

5. Install the controller using the installation procedures for the model or expansion unit on which you are working.

Replacing pdisks

Replace failed pdisks as soon as possible, even if a reconstruction was initiated with a hot spare by the controller. The **Replace/Remove a Device Attached to an SCSI Hot Swap Enclosure Device** option in the SCSI and SCSI RAID Hot Plug Manager can be used to replace failed pdisks. The IBM SAS Disk Array Manager provides a shortcut to the SCSI and SCSI RAID Hot Plug Manager.

Attention: Perform this procedure only if you are directed from an isolation procedure or a maintenance analysis procedure (MAP).

Note: The replacement disk should have a capacity that is greater than or equal to that of the smallest capacity disk in the degraded disk array.

Attention: Always use the SCSI and SCSI RAID Hot Plug Manager for devices attached to an IBM SAS RAID Controller. Do not use utilities intended for other RAID products, such as RAID Hot Plug Devices.

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the **Function Selection** screen.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** .
3. Select **SCSI and SCSI RAID Hot Plug Manager**.
4. Select **Identify a Device Attached to an SCSI Hot Swap Enclosure Device**.
5. Choose the slot corresponding to the pdisk. The visual indicator on the device will blink at the Identify rate.
6. If you are removing a device, select **Replace/Remove a Device Attached to an SCSI Hot Swap Enclosure Device**. The visual indicator on the device will be on solid. Remove the device.
7. If you are installing a device, select **Attach a Device to an SCSI Hot Swap Enclosure Device**. The visual indicator on the device will be on solid. Insert the device.

Replacing an SSD module on the PCIe RAID and SSD SAS adapter

Use this procedure to replace an integrated solid-state drive (SSD) on a PCIe serial-attached SCSI (SAS) RAID and SSD Adapter.

Complete the following steps to perform a nonconcurrent SSD replacement on a PCIe SAS RAID and SSD adapter:

Note: When an SSD on the PCIe adapter fails, the entire adapter must be removed from the system prior to replacing the individual SSD. See the documentation for your system for removing a PCI RAID and SSD SAS adapter from the system.

1. Remove the adapter from the system. See PCI adapters.

   Important: Ensure to follow the concurrent or nonconcurrent replacement procedures depending on the type of data protection enabled:
   * If the data protection is RAID, use the nonconcurrent procedure.
   * If the data protection is mirrored (card to card) and the SSD is located in the 5802 or 5803 expansion unit, use the concurrent procedure.
   * If the data protection is mirrored (card to card) but the SSD is not located in the 5802 or 5803 expansion unit, use the nonconcurrent procedure.

2. Place the adapter on a surface that is electrostatic-discharge protected.
3. Lift the lever **(A)** for the SSD that you are replacing to a fully vertical position.

   Note: Each of the levers **(A)** undocks two SSDs at a time.
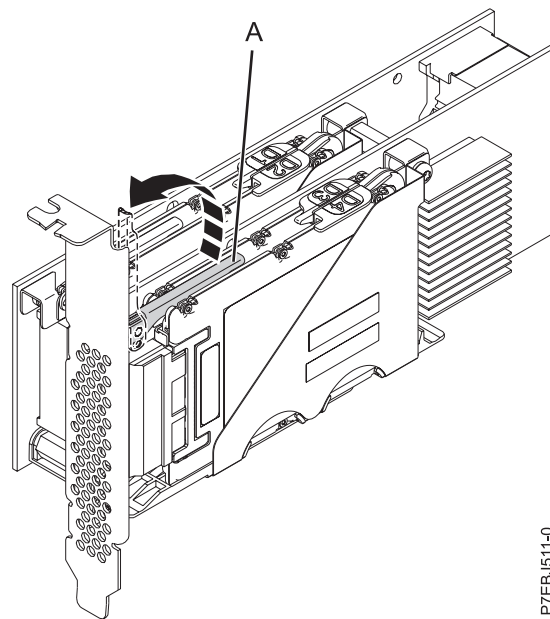
Figure 43. Lifting the levers

4. With the lever **(A)** in the vertical position, firmly push the lever **(A)** away from the adapter tailstock to undock the two SSDs from their connectors.
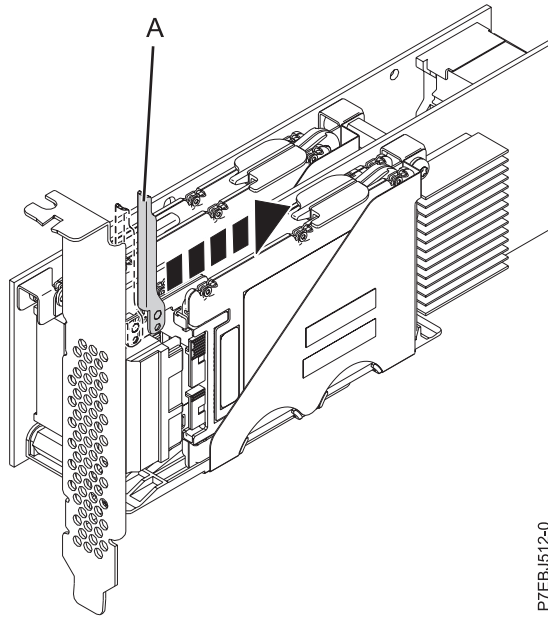
Figure 44. Pushing the lever away from the adapter tailstock

5. Lift the single device retaining latch **(B)** for only the SSD that you are replacing by first moving it away from the center of the SSD divider and then lifting it to a fully vertical position.
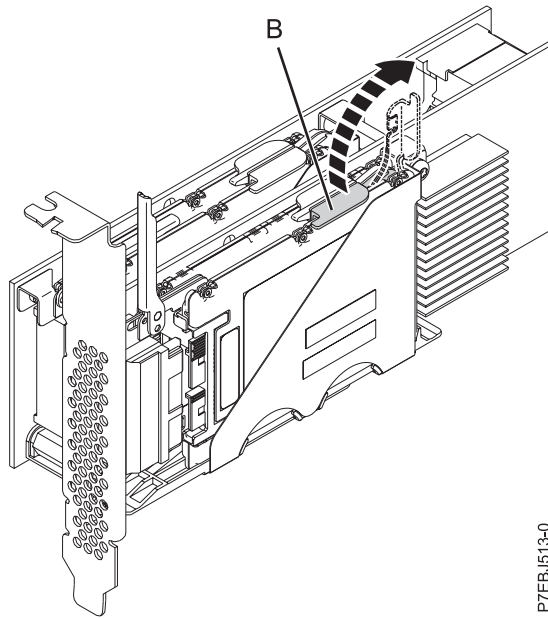
Figure 45. Lifting the device retaining latch

6. Using the device access finger openings **(C)**, push the single SSD that you are replacing out of the device holder.
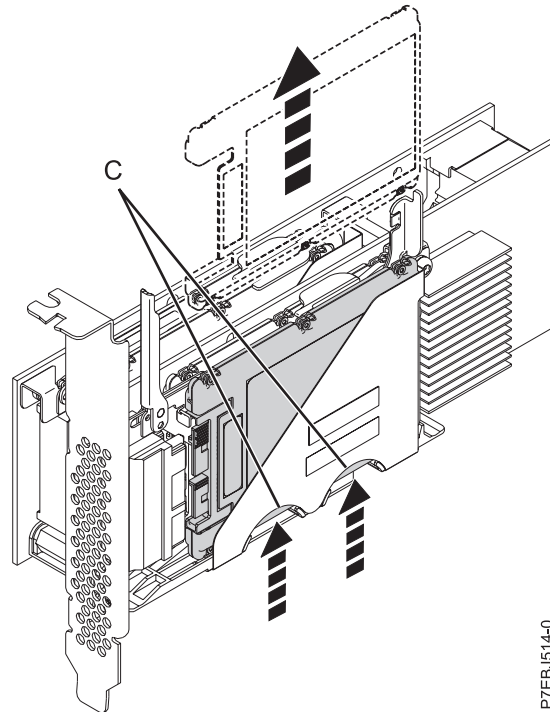
Figure 46. Pushing the SSD that is being replaced

7. Grasp the SSD and continue to remove it from the adapter.
8. Install the replacement SSD by performing steps 7 to 2 on page 98 in the reverse order.

   Note: Ensure that the device retaining latch and undocking lever are in the fully closed position.
9. Reinstall the adapter in the system. See PCI adapters .
10. If you replaced the SSD as a part of another procedure, return to that procedure.

Viewing SAS fabric path information

Use the disk array manager to view details of the SAS fabric information.

Note: Details of the SAS fabric information of all the nodes on the path between the controller and device can be viewed under **Show Fabric Path Data View** and **Show Fabric Path Graphical View**. The only difference between the two menus is the format of the output. The same data is displayed for each choice.

1. Start the IBM SAS Disk Array Manager.
   a. Start the diagnostics program and select **Task Selection** on the Function Selection screen.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options**.
3. Select **Show SAS Controller Physical Resources**.
4. Select **Show Fabric Path Graphical View** or **Show Fabric Path Data View**.
5. Select the IBM SAS RAID controller. The screen displayed will look similar to the following example:

```
+--------------------------------------------------------------------------+
|                  Show SAS Controller Physical Resources                  |
|                                                                          |
|  +--------------------------------------------------------------------+  |
|  |               Show SAS Controller Physical Resources               |  |
|  |                                                                    |  |
|  |  Move cursor to desired item and press Enter.                      |  |
|  |                                                                    |  |
|  |  [TOP]                                                             |  |
|  |    pdisk5      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk0      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk1      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk2      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk6      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk3      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk7      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk11     Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk8      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk4      Path 1: Operational  Path 2: Operational           |  |
|  |    pdisk9      Path 1: Operational  Path 2: Operational           |  |
|  |  [MORE...4]                                                        |  |
|  |                                                                    |  |
|  |  F1=Help              F2=Refresh              F3=Cancel            |  |
|  |  F8=Image             F10=Exit                Enter=Do             |  |
|  |  /=Find               n=Find Next                                  |  |
|  +--------------------------------------------------------------------+  |
+--------------------------------------------------------------------------+
```

Selecting a device will display the details of all the nodes on each path between the controller and the device. Following is an example for **Show Fabric Path Data View**.

```
+--------------------------------------------------------------------------+
|                            COMMAND STATUS                                |
|                                                                          |
| Command: OK            stdout: yes           stderr: no                  |
|                                                                          |
| Before command completion, additional instructions might appear below    |
|                                                                          |
| [TOP]                                                                    |
|                                                                          |
|                                                                          |
| Adapter    Adapter Port  Path Active  Path State   Device                |
| ---------  ------------  -----------  -----------  --------              |
| sissas0    4             Yes          Operational  pdisk0                |
|                                                                          |
| Node  SAS Address       Port Type    Phy  Status           Info         |
| ----  ----------------  -----------  ----  ---------------  -----------  |
| 1     5005076C07037705  Adapter      4     Operational      3.0 GBPS     |
| 2     5FFFFFFFFFFFF000  Expander     14    Operational      3.0 GBPS     |
| 3     5FFFFFFFFFFFF000  Expander     1     Operational      3.0 GBPS     |
| 4     5000C50001C72C29  Device       0     Operational      3.0 GBPS     |
| 5     5000C50001C72C2B  LUN          1     Operational      LUN_ID 000   |
| [MORE...14]                                                              |
|                                                                          |
| F1=Help            F2=Refresh         F3=Cancel         F6=Command       |
| F8=Image           F9=Shell           F10=Exit          /=Find          |
| n=Find Next                                                              |
+--------------------------------------------------------------------------+
```

The possible status values for the **Show Fabric Path Data View** and the **Show Fabric Path Graphical View** follow.

Status	Description
Operational	No problem detected
Degraded	The SAS node is degraded
Failed	The SAS node is failed
Suspect[1]	The SAS node is suspect of contributing to a failure

Status	Description
Missing[1]	The SAS node is no longer detected by the controller
Not valid	The SAS node is incorrectly connected
Unknown	Unknown or unexpected status

[1]This status is an indication of a possible problem; however, the controller is not always able to determine the status of a node. The node can have this status even when the status of th node itself is not displayed.

Example: Using SAS fabric path information

This data becomes helpful in determining the cause of configuration or SAS fabric problems.

The following example assumes a cascaded disk enclosure with a broken connection on one path between the cascaded enclosures.

The state of all paths to all devices displays information similar to the following.

```
+------------------------------------------------------------------------+
|                   Show SAS Controller Physical Resources               |
|                                                                        |
|Move cursor to desired item and press Enter.                            |
|                                                                        |
|  Show Physical Resource Locations                                      |
|  Show Physical Resource Information                                     |
|  Show Fabric Path Graphical View                                       |
|  Show Fabric Path Data View                                            |
|   +--------------------------------------------------------------------+ |
|   |                 Show SAS Controller Physical Resources             | |
|   |                                                                    | |
|   |  Move cursor to desired item and press Enter.                      | |
|   |                                                                    | |
|   |    pdisk0      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk1      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk2      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk3      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk4      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk5      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk6      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk7      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk8      Path 1: Operational  Path 2: Operational            | |
|   |    pdisk9      Path 1: Failed       Path 2: Operational            | |
|   |    pdisk10     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk11     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk12     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk13     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk14     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk15     Path 1: Failed       Path 2: Operational            | |
|   |    pdisk16     Path 1: Failed       Path 2: Operational            | |
|   |    ses0        Path 1: Operational                                 | |
|   |    ses1        Path 1: Operational                                 | |
|   |    ses2        Path 1: Operational                                 | |
|   |    ses3        Path 1: Operational                                 | |
|   |    ses4        Path 1: Operational                                 | |
|   |                                                                    | |
|   |  F1=Help              F2=Refresh              F3=Cancel            | |
|   |  F8=Image             F10=Exit                Enter=Do             | |
|   |  /=Find               n=Find Next                                  | |
|   +--------------------------------------------------------------------+ |
+------------------------------------------------------------------------+
```

For **Show Fabric Path Data View**, choosing one of the devices with a **Failed** path will display information similar to the following.

```
+-------------------------------------------------------------------------------+
|                            COMMAND STATUS                                     |
|                                                                               |
|Command: OK            stdout: yes            stderr: no                        |
|                                                                               |
|Before command completion, additional instructions might appear below.         |
|                                                                               |
|                                                                               |
|                                                                               |
|Adapter    Adapter Port  Path Active  Path State   Device                      |
|---------  ------------  -----------  -----------  --------                     |
|sissas0    4             No           Failed       pdisk9                       |
|                                                                               |
|Node  SAS Address       Port Type    Phy   Status            Info              |
|----  ----------------  -----------  ----  ----------------  -----------       |
|1     5005076C0701CD05  Adapter      4     Operational       3.0 GBPS          |
|2     500A0B8257CC9000  Expander     16    Operational       3.0 GBPS          |
|3     0000000000000000  Expander     FF    Missing           Status 0          |
|4     5000CCA003100DF3  LUN          40    Missing           Status 0          |
|                                                                               |
|                                                                               |
|Adapter    Adapter Port  Path Active  Path State   Device                      |
|---------  ------------  -----------  -----------  --------                     |
|sissas0    6             Yes          Operational  pdisk9                       |
|                                                                               |
|Node  SAS Address       Port Type    Phy   Status            Info              |
|----  ----------------  -----------  ----  ----------------  -----------       |
|1     5005076C0701CD07  Adapter      6     Operational       3.0 GBPS          |
|2     500A0B8257CEA000  Expander     16    Operational       3.0 GBPS          |
|3     500A0B8257CEA000  Expander     10    Operational       3.0 GBPS          |
|4     500A0B81E18E7000  Expander     10    Operational       3.0 GBPS          |
|5     500A0B81E18E7000  Expander     0     Operational       3.0 GBPS          |
|6     5000CCA003900DF3  Device       1     Operational       3.0 GBPS          |
|7     5000CCA003100DF3  LUN          40    Operational       LUN_ID 000        |
+-------------------------------------------------------------------------------+
```

For **Show Fabric Path Graphical View**, choosing one of the devices with a **Failed** path will display information similar to the following.

```
+------------------------------------------------------------------------------+
|                             COMMAND STATUS                                   |
|                                                                              |
| Command: OK              stdout: yes              stderr: no                 |
|                                                                              |
| Before command completion, additional instructions might appear below.      |
| *************************************************************************    |
| Path(s) from sissas0 to the pdisk9.                                         |
| *************************************************************************    |
| +--------------------------------------------------------------------+      |
| |Path Active: No          Adapter     Path Active: Yes               |      |
| |Path State : Failed       sissas0     Path State : Operational       |      |
| +--------------------------+------------+--------------------------+  |      |
| |SAS Addr: 5005076C0701CD05 |           |SAS Addr: 5005076C0701CD07 | |      |
| |Port    : 4               |           |Port    : 6               | |      |
| |Status  : Operational     |           |Status  : Operational     | |      |
| |Info    : 3.0 GBPS        |           |Info    : 3.0 GBPS        | |      |
| +--------------------------+           +--------------------------+ |      |
|            ||                                    ||                 |      |
|            \/                                    \/                 |      |
| +--------------------------+           +--------------------------+ |      |
| |     Expander : 1         |           |     Expander : 1         | |      |
| +--------------------------+           +--------------------------+ |      |
| |SAS Addr: 500A0B8257CC9000 |           |SAS Addr: 500A0B8257CEA000 | |      |
| |Port    : 16              |           |Port    : 16              | |      |
| |Status  : Operational     |           |Status  : Operational     | |      |
| |Info    : 3.0 GBPS        |           |Info    : 3.0 GBPS        | |      |
| +--------------------------+           +--------------------------+ |      |
| |SAS Addr: 0000000000000000 |           |SAS Addr: 500A0B8257CEA000 | |      |
| |Port    : FF              |           |Port    : 10              | |      |
| |Status  : Missing         |           |Status  : Operational     | |      |
| |Info    : Status 0        |           |Info    : 3.0 GBPS        | |      |
| +--------------------------+           +--------------------------+ |      |
|            ||                                    ||                 |      |
|            ||                                    \/                 |      |
|            ||                          +--------------------------+ |      |
|            ||                          |     Expander : 2         | |      |
|            ||                          +--------------------------+ |      |
|            ||                          |SAS Addr: 500A0B81E18E7000 | |      |
|            ||                          |Port    : 10              | |      |
|            ||                          |Status  : Operational     | |      |
|            ||                          |Info    : 3.0 GBPS        | |      |
|            ||                          +--------------------------+ |      |
|            ||                          |SAS Addr: 500A0B81E18E7000 | |      |
|            ||                          |Port    : 0               | |      |
|            ||                          |Status  : Operational     | |      |
|            ||                          |Info    : 3.0 GBPS        | |      |
|            ||                          +--------------------------+ |      |
|            ||                                    ||                 |      |
|            ||                                    \/                 |      |
|            ||                          +--------------------------+ |      |
|            ||                          |        Device            | |      |
|            ||                          +--------------------------+ |      |
|            ||                          |SAS Addr: 5000CCA003900DF3 | |      |
|            ||                          |Port    : 1               | |      |
|            ||                          |Status  : Operational     | |      |
|            \/                          |Info    : 3.0 GBPS        | |      |
| +--------------------------+------------+--------------------------+ |      |
| |SAS Addr: 5000CCA003100DF3 | Device Lun |SAS Addr: 5000CCA003100DF3 | |      |
| |Status  : Missing         | pdisk9     |Status  : Operational     | |      |
| |Info    : LUN_ID 000      |           |Info    : LUN_ID 000      | |      |
| +--------------------------+------------+--------------------------+ |      |
| +--------------------------------------------------------------------+      |
+------------------------------------------------------------------------------+
```

Problem determination and recovery

AIX diagnostics and utilities are used to assist in problem determination and recovery tasks.

Note: The procedures contained in this section are intended for service representatives specifically trained on the system unit and subsystem that is being serviced. Additionally, some of the service actions in this topic might require involvement of the system administrator.

If a problem arises related to disk arrays and associated pdisks, use the following to identify the problem:
- Information presented by the error log analysis
- Hardware error logs viewed using the Display Hardware Error Report diagnostic task
- Disk array hdisk and pdisk status, viewed using the IBM SAS Disk Array Manager

Error log analysis analyzes errors presented by the adapter, and recommends actions that need to be performed to correct the errors. It is sometimes recommended that you perform a maintenance analysis procedure (MAP) to further determine what actions should be taken to resolve the problem.

The MAPs contained in this topic are intended to address only problems directly related to disk arrays and SAS problem isolation. MAPs related to other device or adapter problems, when applicable, are located in other system documentation.

Read the following before using these problem determination and recovery procedures:
- If a disk array is being used as a boot device and the system fails to boot because of a suspected disk-array problem, boot using the Standalone Diagnostic media. Error log analysis, AIX error logs, the IBM SAS Disk Array Manager, and other tools are available on the Standalone Diagnostics to help determine and resolve the problem with the disk array.
- When invoking diagnostic routines for a controller, use the Problem Determination (PD) mode instead of System Verification (SV) mode unless there is a specific reason to use SV mode (for example, you were directed to run SV mode by a MAP).
- After diagnostic routines for a controller are run in SV mode, run the diagnostics in PD mode to ensure that new errors are analyzed. Perform these actions especially when using Standalone Diagnostic media.

SAS resource locations

Many hardware error logs identify the location of a physical device, such as a SAS disk, using what is called a *resource location* (or simply *resource*).

SAS resource locations for PCI-X and PCIe controllers, except CCIN 57CD

The resource format is: *00cceell* where:
- *cc* identifies the controller's port to which the device, or device enclosure, is attached.
- *ee* is the expander's port to which the device is attached. When a device is not connected to a SAS expander, for example, the device is directly connected, the expander port is set to zero.

  Typically, the expander port will be in a range of 00 to 3F hex. A value greater than 3F indicates there are two expanders (for example, cascaded expanders) between the controller and device. For example, a device connected through a single expander might show an expander port of 1A, while a device connected through a cascaded expander might show an expander port of 5A (that is, a value of 40 hex added to the expander port indicates the presence of a cascaded expander), but in both cases, the device is connected off port 1A of the expander.

A value of FF indicates the expander port is not known.
* *ll* is the logical unit number (LUN) of the device.
  A value of FF indicates the LUN is not known.

The resource location is also used to identify a disk array. For a disk array, the resource format is: *00FFnn00* where:
* *nn* is the controller disk array identifier.

A resource can identify a physical device, a disk array, or it can identify other SAS components. For example:
* 00FFFFFF indicates the identity of the device is not known.
* 00ccFFFF identifies only a controller's SAS port.
* 00cceell identifies the controller port, expander port, and LUN of an attached device.
* 00FE0000 indicates a remote SAS initiator
* 00FFnn00 indicates a disk array
* FFFFFFFF indicates a SAS RAID controller.
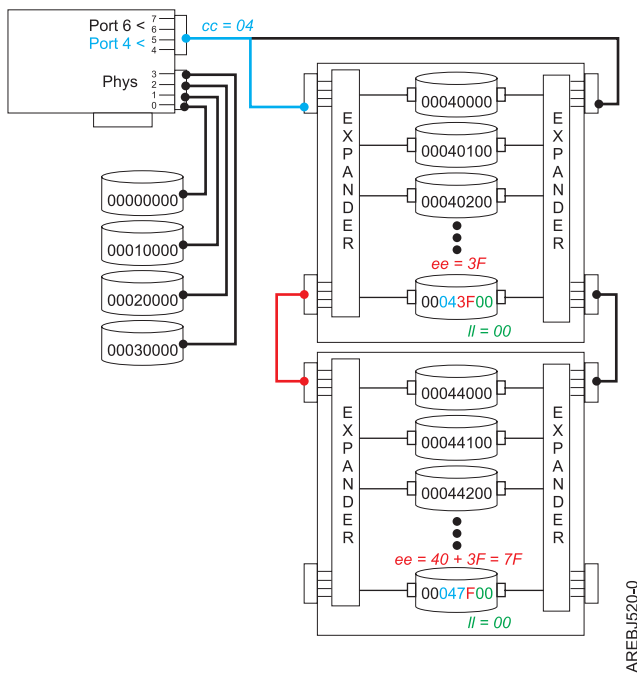
Figure 47. Example SAS subsystem resource locations

SAS resource locations for PCIe controller 57CD

The following figure depicts the resource locations for the CCIN 57CD PCIe SAS RAID and SSD Adapter. Each of the integrated SSDs is directly connected, and thus the expander port is equal to 0 in the resource. The LUN of each device is also zero.

Slot Label: D1
Resource: 00000000

Slot Label: D3
Resource: 00040000

Slot Label: D2
Resource: 00010000

Slot Label: D4
Resource: 00050000

P7EBJ510-1
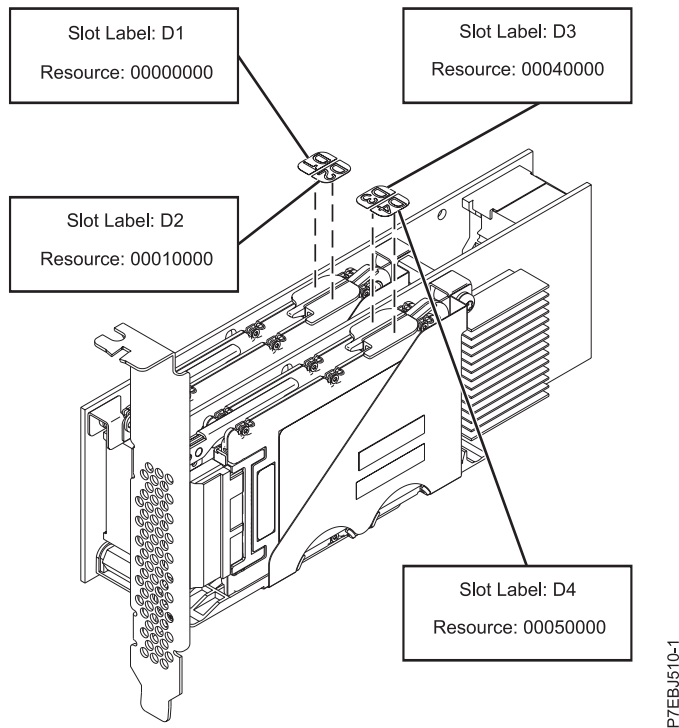
Figure 48. SAS resource locations for CCIN 57CD PCIe SAS RAID and 3 Gb x8 SSD Adapter

SAS resource locations for PCIe2 controllers

The resource format is: *ttcceess* where:

- *tt* identifies the type of device.

   Note: A value of 00 indicates the device is a physical device (HDD or SSD). A value other than 00 indicates the device is a logical device or a SAS RAID controller.
- *cc* identifies the controller's port to which the device, or device enclosure, is attached.
- *ee* is the expander's port to which the device, or cascaded expander, is attached. When a device is not connected to a SAS expander, for example, the device is directly connected, the expander port is set to FF.

   A value of FF indicates the expander port is not known or no expander exists.
- *ss* is the cascaded expander's port to which the device is attached.

   A value of FF indicates the cascaded expander port is not known or no cascaded expander exists.

The resource location is also used to identify a disk array. For a disk array, the resource format is: *FCnn00FF* where:

- *nn* is the controller disk array identifier.

A resource can identify a physical device, a disk array, or it can identify other SAS components. For example:

- 00FFFFFF indicates the identity of the device is not known.
- 00ccFFFF identifies only a controller's SAS port or a directly attached device.
- 00cceeFF identifies the controller port and expander port of an attached device.
- 00cceess identifies the controller port, expander port, and cascaded expander port of an attached device.
- FB0000FF indicates a remote SAS initiator

- FCnn00FF indicates a disk array
- FFFFFFFF indicates a SAS RAID controller.

Note: In most places (such as the SMIT screens) only the top 4 bytes of the Resource field is shown. However, in some error logs the Resource is identified with an 8 byte value. The ending 4 bytes are always FFFFFFFF and can be ignored in all supported configurations.

For example, the resource identified in the following snippet from an error log would be resource 000608FF.

```
DISK INFORMATION


Resource         Vendor    Product   S/N        World Wide ID


000608FFFFFFFFFF IBM       SG9XCA2E 50B00460 500051610000FC6C0000000000000000
```
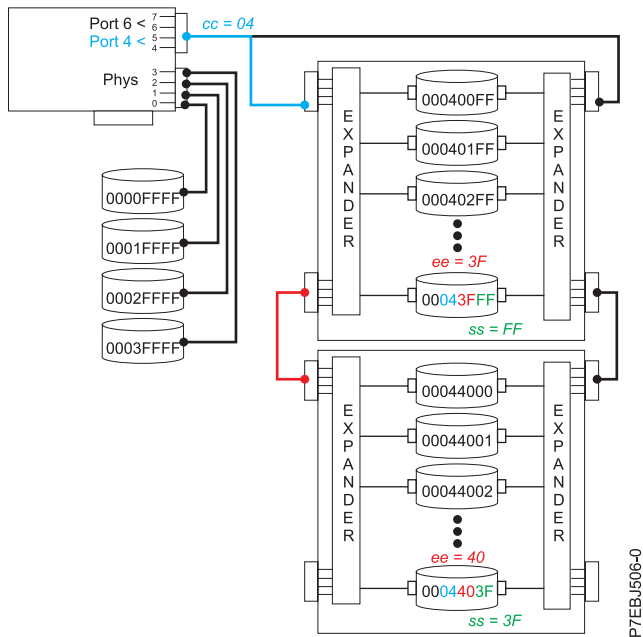

Figure 49. Example PCIe2 SAS subsystem resource locations

Showing physical resource attributes

Use this procedure to determine attributes of the device such as physical location, hdisk name, pdisk name, serial number, or worldwide ID.

1. Start the IBM SAS Disk Array Manager.
   a. Start the diagnostics program and select **Task Selection** on the Function Selection screen.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options**.
3. Select **Show SAS Controller Physical Resources**.

4. Select **Show Physical Resource Locations** or **Show Physical Resource Information**. The Show
   Physical Resource Locations screen and Show Physical Resource Information screen look similar to the
   following screens.

```
+--------------------------------------------------------------------------------+
|                           COMMAND STATUS                                       |
|                                                                                |
| Command: OK            stdout: yes            stderr: no                        |
|                                                                                |
| Before command completion, additional instructions might appear below.         |
|                                                                                |
| ---------------------------------------------------------------------          |
| Name       Resource  Physical Location                                         |
| ---------------------------------------------------------------------          |
| sissas0    FFFFFFFF  U789D.001.DQDVXHA-P1-T3                                    |
|                                                                                |
| hdisk2     00FF0000  U789D.001.DQDVXHA-P1-T3-LFF0000-L0                         |
|  pdisk0    00000400  U789D.001.DQDVXHA-P3-D3                                    |
|                                                                                |
| hdisk0     00000200  U789D.001.DQDVXHA-P3-D1                                    |
| hdisk1     00000300  U789D.001.DQDVXHA-P3-D2                                    |
| ses0       00080000  U789D.001.DQDVXHA-P4                                       |
| ses1       00000A00  U789D.001.DQDVXHA-P3                                       |
| ses2       00020A00  U789D.001.DQDVXHA-P3                                       |
| cd0        00040000  U789D.001.DQDVXHA-P4-D1                                    |
|                                                                                |
|                                                                                |
| F1=Help            F2=Refresh           F3=Cancel           F6=Command          |
| F8=Image           F9=Shell             F10=Exit            /=Find              |
| n=Find Next                                                                     |
+--------------------------------------------------------------------------------+
```

```
+--------------------------------------------------------------------------------+
|                           COMMAND STATUS                                       |
|                                                                                |
| Command: OK            stdout: yes            stderr: no                        |
|                                                                                |
| Before command completion, additional instructions might appear below.         |
|                                                                                |
| ---------------------------------------------------------------------          |
| Name       Location  Resource  World Wide ID      Serial Number                |
| ---------------------------------------------------------------------          |
| sissas0    07-08     FFFFFFFF  5005076C0301C700                                 |
|                                                                                |
| hdisk2     07-08-00  00FF0000  n/a                84A40E3D                      |
|  pdisk0    07-08-00  00000400  5000CCA00336D2D9   0036D2D9                      |
|                                                                                |
| hdisk0     07-08-00  00000200  5000cca00336f5db                                |
| hdisk1     07-08-00  00000300  5000cca00336d2d4                                |
| ses0       07-08-00  00080000  5005076c06028800                                |
| ses1       07-08-00  00000A00  5005076c0401170e                                |
| ses2       07-08-00  00020A00  5005076c0401178e                                |
| cd0        07-08-00  00040000                                                  |
|                                                                                |
|                                                                                |
| F1=Help            F2=Refresh           F3=Cancel           F6=Command          |
| F8=Image           F9=Shell             F10=Exit            /=Find              |
| n=Find Next                                                                     |
+--------------------------------------------------------------------------------+
```

Disk array problem identification

Use service request numbers (SRNs), posted by the AIX diagnostics, to identify problems in disk arrays.

A disk array problem is uniquely identified by an SRN. An SRN is in the format nnnn - rrrr, where the first four digits of the SRN preceding the dash (-) is known as the failing function code (FFC, for example 2502) and the last four digits of the SRN following the dash (-) is known as the reason code. The reason code indicates the specific problem that has occurred and must be obtained in order to determine which maintenance analysis procedure (MAP) to use.

An SRN is provided by error log analysis, which directs you to the MAPs contained in this topic. To obtain the reason code (last 4 digits of the SRN) from an AIX error log, see "Finding a service request number from an existing AIX error log" on page 205.

The SRN describes the problem that has been detected and should be considered the primary means of identifying a problem. However, the List SAS Disk Array Configuration option within the IBM SAS Disk Array Manager is also useful in identifying a problem or confirming a problem described by error log analysis. For additional information about the IBM SAS Disk Array Manager, see "Using the Disk Array Manager" on page 33.

Obtain the SRN and proceed to the next section to obtain a more detailed description of the problem and to determine which MAP to use.

Service request numbers

With a service request number (SRN) obtained from error log analysis or from the AIX error log, use the following table to determine which maintenance analysis procedures (MAPs) to use.

The following table includes only SRNs that are associated with the MAPs contained in this document.

Table 15. SRN to MAP index

SRN	Description	MAP
nnnn-101	Controller configuration error	MAP 210 – replace controller
nnnn-710 nnnn-713	Controller failure	MAP 210 – replace controller
nnnn-720	Controller device bus configuration error	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4150 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4050 • For all other values of nnnn, use "MAP 3150" on page 154 for a PCI-X or PCIe controller or use "MAP 3250" on page 194 for a PCIe2 controller
nnnn-102E	Out of alternate disk storage for storage	MAP 210 – replace disk
nnnn-3002	Addressed device failed to respond to selection	MAP 210 – replace device
nnnn-3010	Disk returned wrong response to controller	MAP 210 – replace disk

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-3020 nnnn-3100 nnnn-3109 nnnn-310C nnnn-310D nnnn-3110	Various errors requiring SAS fabric problem isolation	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4150 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4050 • For all other values of nnnn, use "MAP 3150" on page 154 for a PCI-X or PCIe controller or use "MAP 3250" on page 194 for a PCIe2 controller
nnnn-4010	Configuration error, incorrect connection between cascaded enclosures	"MAP 3142" on page 142 for a PCI-X or PCIe controller or "MAP 3242" on page 183 for a PCIe2 controller
nnnn-4020	Configuration error, connections exceed controller design limits	"MAP 3143" on page 143 for a PCI-X or PCIe controller or "MAP 3243" on page 184 for a PCIe2 controller
nnnn-4030	Configuration error, incorrect multipath connection	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4144 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4044 • For all other values of nnnn, use "MAP 3144" on page 144 for a PCI-X or PCIe controller or "MAP 3244" on page 185 for a PCIe2 controller
nnnn-4040	Configuration error, incomplete multipath connection between controller and enclosure detected	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4144 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4044 • For all other values of nnnn, use "MAP 3144" on page 144 for a PCI-X or PCIe controller or "MAP 3244" on page 185 for a PCIe2 controller
nnnn-4041	Configuration error, incomplete multipath connection between enclosures and device detected	"MAP 3146" on page 149 for a PCI-X or PCIe controller or "MAP 3246" on page 190 for a PCIe2 controller
nnnn-4050	Attached enclosure does not support required multipath function	"MAP 3148" on page 153 for a PCI-X or PCIe controller or "MAP 3248" on page 193 for a PCIe2 controller

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-4060	Multipath redundancy level got worse	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4153 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4053 • For all other values of nnnn, use "MAP 3153" on page 161 for a PCI-X or PCIe controller or "MAP 3253" on page 201 for a PCIe2 controller
nnnn-4080	Thermal error, controller exceeded maximum operating temperature	MAP 3295 for a PCIe2 controller
nnnn-4085	Please contact your next level of support or service provider	MAP 3290 for a PCIe2 controller
nnnn-4100	Device bus fabric error	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4152 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4052 • For all other values of nnnn, use "MAP 3152" on page 158 for a PCI-X or PCIe controller or "MAP 3252" on page 198 for a PCIe2 controller
nnnn-4101	Temporary device bus fabric error	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4152 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4052 • For all other values of nnnn, use "MAP 3152" on page 158 for a PCI-X or PCIe controller or "MAP 3252" on page 198 for a PCIe2 controller
nnnn-4102	Device bus fabric performance degradation	"MAP 3254" on page 203 for a PCIe2 controller
nnnn-4110	Unsupported enclosure function detected	"MAP 3145" on page 148 or a PCI-X or PCIe controller or "MAP 3245" on page 189 for a PCIe2 controller
nnnn-4120	Configuration error, cable VPD cannot be read	"MAP 3261" on page 203 for a PCIe2 controller
nnnn-4121	Configuration error, required cable is missing	"MAP 3261" on page 203 for a PCIe2 controller
nnnn-4123	Configuration error, invalid cable Vital Product Data	"MAP 3261" on page 203 for a PCIe2 controller
nnnn-4150 nnnn-4160	PCI Bus error detected by controller	MAP 210 – replace controller, if the problem is not fixed, replace the planar or backplane

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-4170	Controller T10 DIF host bus error	"MAP 3260" on page 203 for a PCIe2 controller
nnnn-4171	Controller recovered T10 DIF host bus error	"MAP 3260" on page 203 for a PCIe2 controller
nnnn-7001	Temporary disk data error	MAP 210 – replace disk
nnnn-8008 nnnn-8009	A permanent cache battery pack failure occurred Impending cache battery pack failure	"MAP 3100" on page 118 for a PCI-X or PCIe controller
nnnn-8150 nnnn-8157	Controller Failure	MAP 210 – replace controller
nnnn-9000 nnnn-9001 nnnn-9002	Controller detected device error during configuration discovery	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9008	Controller does not support function expected for one or more disk	"MAP 3130" on page 128 for a PCI-X or PCIe controller or "MAP 3230" on page 172 for a PCIe2 controller
nnnn-9010	Cache data associated with attached disks cannot be found	"MAP 3120" on page 125 for a PCI-X or PCIe controller or "MAP 3220" on page 171 for a PCIe2 controller
nnnn-9011	Cache data belongs to disks other than those attached	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9020 nnnn-9021 nnnn-9022	Two or more disks are missing from a RAID 5 or RAID 6 Disk Array	"MAP 3111" on page 121 for a PCI-X or PCIe controller or "MAP 3211" on page 166 for a PCIe2 controller
nnnn-9023	One or more disk array members are not at required physical locations	"MAP 3112" on page 122 for a PCI-X or PCIe controller or "MAP 3212" on page 168 for a PCIe2 controller
nnnn-9024	Physical location of disk array members conflict with another disk array	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9025	Incompatible disk installed at degraded disk location in disk array	"MAP 3110" on page 119 for a PCI-X or PCIe controller or "MAP 3210" on page 164 for a PCIe2 controller
nnnn-9026	Previously degraded disk in disk array not found at required physical location	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9027	Disk array is or would become degraded and parity data is out of synchronization	"MAP 3113" on page 124 for a PCI-X or PCIe controller or "MAP 3213" on page 169 for a PCIe2 controller
nnnn-9028	Maximum number of functional disk arrays has been exceeded	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-9029	Maximum number of functional disk array disks has been exceeded	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9030	Disk array is degraded due to missing/failed disk	"MAP 3110" on page 119 for a PCI-X or PCIe controller or "MAP 3210" on page 164 for a PCIe2 controller
nnnn-9031	Automatic reconstruction initiated for Disk Array	"MAP 3110" on page 119 for a PCI-X or PCIe controller or "MAP 3210" on page 164 for a PCIe2 controller
nnnn-9032	Disk array is degraded due to a missing or failed disk	"MAP 3110" on page 119 for a PCI-X or PCIe controller or "MAP 3210" on page 164 for a PCIe2 controller
nnnn-9041	Background disk array parity checking detected and corrected errors	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9042	Background disk array parity checking detected and corrected errors on specified disk	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9050	Required cache data can not be located for one or more disks	"MAP 3131" on page 130 for a PCI-X or PCIe controller or "MAP 3231" on page 173 for a PCIe2 controller
nnnn-9051	Cache data exists for one or more missing or failed disks	"MAP 3132" on page 134 for a PCI-X or PCIe controller or "MAP 3232" on page 175 for a PCIe2 controller
nnnn-9052	Cache data exists for one or more modified disks	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9054	RAID controller resources not available due to previous problems	"MAP 3121" on page 128 for a PCI-X or PCIe controller or "MAP 3221" on page 171 for a PCIe2 controller
nnnn-9060	One or more disk pairs are missing from a RAID 10 disk array	"MAP 3111" on page 121 for a PCI-X or PCIe controller or "MAP 3211" on page 166 for a PCIe2 controller
nnnn-9061 nnnn-9062	One or more disks are missing from a RAID 0 disk array	"MAP 3111" on page 121 for a PCI-X or PCIe controller or "MAP 3211" on page 166 for a PCIe2 controller
nnnn-9063	Maximum number of functional disk arrays has been exceeded	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9073	Multiple controllers connected in an invalid configuration	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4140 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4040 • For all other values of nnnn, use "MAP 3140" on page 140 for a PCI-X or PCIe controller or "MAP 3240" on page 181 for a PCIe2 controller

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-9074	Multiple controllers not capable of similar functions or controlling same set of devices	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4141 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4041 • For all other values of nnnn, use "MAP 3141" on page 140 for a PCI-X or PCIe controller or "MAP 3241" on page 181 for a PCIe2 controller
nnnn-9075	Incomplete multipath connection between controller and remote controller	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4149 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4049 • For all other values of nnnn, use "MAP 3149" on page 154 for a PCI-X or PCIe controller or "MAP 3249" on page 194 for a PCIe2 controller
nnnn-9076	Missing remote controller	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4147 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4047 • For all other values of nnnn, use "MAP 3147" on page 152 for a PCI-X or PCIe controller or "MAP 3247" on page 192 for a PCIe2 controller
nnnn-9081 nnnn-9082	Controller detected device error during internal media recovery	"MAP 3190" on page 164 for a PCI-X or PCIe controller or "MAP 3290" on page 204 for a PCIe2 controller
nnnn-9090	Disk has been modified after last known status	"MAP 3133" on page 135 for a PCI-X or PCIe controller or "MAP 3233" on page 176 for a PCIe2 controller
nnnn-9091	Incorrect disk configuration change has been detected	"MAP 3133" on page 135 for a PCI-X or PCIe controller or "MAP 3233" on page 176 for a PCIe2 controller
nnnn-9092	Disk requires format before use	"MAP 3134" on page 136 for a PCI-X or PCIe controller or "MAP 3234" on page 177 for a PCIe2 controller
nnnn-FF3D	Temporary controller failure	MAP 210 – replace controller
nnnn-FFF3	Disk media format bad	"MAP 3135" on page 139 for a PCI-X or PCIe controller or "MAP 3235" on page 180 for a PCIe2 controller

Table 15. SRN to MAP index (continued)

SRN	Description	MAP
nnnn-FFF4 nnnn-FFF6 nnnn-FFFA	Disk error	MAP 210 – replace disk
nnnn-FFFC	Device recovered T10 DIF device bus error	"MAP 3250" on page 194 for a PCIe2 controller
nnnn-FFFD	Controller recovered T10 DIF device bus error	"MAP 3250" on page 194 for a PCIe2 controller
nnnn-FFFE	Various errors requiring SAS fabric problem isolation	SRNs are associated with MAPs based on the value of nnnn. • If nnnn is 2D14 or 2D15, use MAP4150 • If nnnn is 2D16 - 2D18 or 2D26 - 2D28, use MAP4050 • For all other values of nnnn, use "MAP 3150" on page 154 for a PCI-X or PCIe controller or "MAP 3250" on page 194 for a PCIe2 controller

Controller maintenance analysis procedures

These procedures are intended to resolve adapter, cache, or disk array problems associated with a controller.

See "Service request numbers" on page 112 to identify which MAP to use.

Examining the hardware error log

The AIX hardware error log is where the operating system keeps records about hardware errors, including disk arrays.

Note: Run diagnostics in Problem Determination (PD) mode to ensure that new errors are analyzed. These actions should be performed especially when using standalone diagnostic media.

1. Start the diagnostics program and select **Task Selection** on the Function Selection screen.
2. Select **Display Hardware Error Report**.
3. Select **Display Hardware Errors for IBM SAS RAID Adapters**.
4. Select the adapter resource, or select all adapters resources if the adapter resource is not known.
5. On the Error Summary screen, look for an entry with a SRN corresponding to the problem which sent you here and select it. If multiple entries exist for the SRN, some entries could be older versions or a problem has occurred on multiple entities (such as adapters, disk arrays, and devices). Older entries can be ignored, however, the MAP might need to be used multiple times if the same problem has occurred on multiple entities.
6. Return to the MAP that sent you here and continue with the steps in that MAP.

MAP 3100

Use this MAP to resolve the following problems:

• A permanent cache battery pack failure occurred (SRN nnnn-8008) for a PCI-X or PCIe controller
• Impending cache battery pack failure (SRN nnnn-8009) for a PCI-X or PCIe controller

Step 3100-1

Prior to replacing the cache battery pack, it must be forced into an error state. This will ensure that write caching is stopped prior to replacing the battery pack thus preventing possible data loss.

1. Follow the steps described in Forcing a rechargeable battery error.
2. Go to "Step 3100-2."

Step 3100-2

Follow the actions recommended in Replacing a battery pack.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3110

Use this MAP to resolve the following problems:

- Incompatible disk installed at the degraded disk location in the disk array (SRN *nnnn*-9025) for a PCI-X or PCIe controller.
- Disk array is degraded due to a missing or failed disk (SRN *nnnn*-9030) for a PCI-X or PCIe controller.
- Automatic reconstruction initiated for a disk array (SRN *nnnn*-9031) for a PCI-X or PCIe controller.
- Disk array is degraded due to a missing or failed disk (SRN *nnnn*-9032) for a PCI-X or PCIe controller.

Step 3110-1

Identify the disk array by examining the hardware error log.

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. This error log displays the following disk array information under the heading **Array Information** : **Resource**, **S/N** (serial number), and **RAID Level**.
3. Go to "Step 3110-2."

Step 3110-2

View the current disk array configuration as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration**.
3. Select the IBM SAS RAID Controller identified in the hardware error log.
4. Go to Step "Step 3110-3."

Step 3110-3

Does a disk array have a state of **Degraded**?

No   Go to "Step 3110-4."

Yes   Go to "Step 3110-5" on page 120.

Step 3110-4

The affected disk array should have a state of either **Rebuilding** or **Optimal** due to the use of a hot spare disk.

Identify the failed disk, which is no longer a part of the disk array, by finding the pdisk listed at the bottom of the display that has a state of either **Failed** or **RWProtected**. Using appropriate service procedures, such as use of the SCSI and SCSI RAID Hot Plug Manager, remove the failed disk and replace it with a new disk to use as a hot spare. See the "Replacing pdisks" on page 97 section for this procedure, and then continue here.

Return to the List SAS Disk Array Configuration display in the IBM SAS Disk Array Manager. If the new disk is not listed as a pdisk, it might first need to be prepared for use in a disk array. complete the following steps:
1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Create an Array Candidate pdisk and Format to 528 Byte Sectors**.
3. Select the appropriate IBM SAS RAID Controller.
4. Select the disks from the list that you want to prepare for use in the disk arrays.

In order to make the new disk usable as a hot spare, complete the following steps:
1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Change/Show SAS pdisk Status** > **Create a Hot Spare** > **IBM SAS RAID Controller**.
3. Select the pdisk that you want to designate as a hot spare.

Note: Hot spare disks are useful only if their capacity is greater than or equal to that of the smallest capacity disk in a disk array that becomes **Degraded**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3110-5

Identify the failed disk by finding the pdisk listed for the degraded disk array that has a state of **Failed**. Using appropriate service procedures, such as the SCSI and SCSI RAID Hot Plug Manager, remove the failed disk and replace it with a new disk to use in the disk array. Refer to the "Replacing pdisks" on page 97 section for this procedure, and then continue here.

Note:

If the failed device is on a PCIe SAS RAID and SSD adapter, complete the following steps and then continue here:
1. Use the resource information shown for the failed pdisk and identify the device location on the adapter. For more information, see SAS resource locations.
2. Replace the device as described in Replacing a disk drive with the system or logical partition powered off.

Note: The replacement disk should have a capacity that is greater than or equal to that of the smallest capacity disk in the degraded disk array.

To bring the disk array back to a state of **Optimal**, complete the following steps:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager** > **Reconstruct a SAS Disk Array**.

2. Select the failed pdisk to reconstruct.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3111

Use this MAP to resolve the following problems:

- Two or more disks are missing from a RAID 5 or RAID 6 disk array (service request number (SRN) *nnnn*-9020, *nnnn*-9021, or *nnnn*-9022) for a PCI-X or PCIe controller.
- One or more disk pairs are missing from a RAID 10 disk array (SRN *nnnn*-9060) for a PCI-X or PCIe controller.
- One or more disks are missing from a RAID 0 disk array (SRN *nnnn*-9061, *nnnn*-9062) for a PCI-X or PCIe controller.

Step 3111-1

Identify the disks missing from the disk array by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, the missing disks are those listed under **Array Member Information** with an **Actual Resource** of ***unkwn***.
3. Go to "Step 3111-2."

Step 3111-2

Perform only one of the following options, listed in the order of preference:

Option 1

>   Locate the identified disks and install them in the correct physical locations (that is, the **Expected Resource** field) in the system. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Expected Resource** field.
>
>   After installing the disks in the locations shown in the **Expected Resource** field, complete only one of the following options:
>
>   - Run diagnostics in system verification mode on the adapter:
>   1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2. Select **Run Diagnostics**.
>   3. Select the adapter resource.
>   4. Select **System Verification**.
>   - Unconfigure and reconfigure the adapter by performing the following steps:
>   1. Unconfigure the adapter.
>   a. Start the IBM SAS Disk Array Manager.
>   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
>   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
>   2. Configure the adapter.
>   a. Start the IBM SAS Disk Array Manager.
>   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.
 • Perform an IPL of the system or logical partition.

   When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2
   Delete the disk array, as follows:

   Attention: All data on the disk array will be lost.
   1. Start the IBM SAS Disk Array Manager.
      a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
   3. Select the disk array to delete.

   When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3
   Format the remaining members of the disk array, as follows:

   Attention: All data on the disk array will be lost.
   1. Start the IBM SAS Disk Array Manager.
      a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
      b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

   When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3112

Use this MAP to resolve the following problem: One or more disk array members are not at required physical locations (SRN *nnnn*-9023) for a PCI-X or PCIe controller.

Step 3112-1

Identify the disks which are not at their required physical locations by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the disks which are not at their required locations are those listed under **Array Member Information** with an **Expected Resource** and **Actual Resource** which do not match.

   An **Actual Resource** of ***unkwn*** is acceptable, and no action is needed to correct it. This ***unkwn*** location should only occur for the disk array member that corresponds to the **Degraded Disk S/N**.
3. Go to "Step 3112-2."

Step 3112-2

Perform only one of the following options, listed in the order of preference:

Option 1
   Locate the identified disks and install them in the correct physical locations (that is, the **Expected**

Resource field) in the system. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Expected Resource** field.

After installing the disks in the locations shown in the **Expected Resource** field, complete only one of the following options:

- Run diagnostics in system verification mode on the adapter:
  1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
  2. Select **Run Diagnostics**.
  3. Select the adapter resource.
  4. Select **System Verification**.
- Unconfigure and reconfigure the adapter by performing the following steps:
  1. Unconfigure the adapter.
     a. Start the IBM SAS Disk Array Manager.
        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
     b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
  2. Configure the adapter.
     a. Start the IBM SAS Disk Array Manager.
        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
     b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.
- Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Delete the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the remaining members of the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.
   a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3113

Use this MAP to resolve the following problem: Disk array is or would become degraded and parity data is out of synchronization (SRN nnnn-9027) for a PCI-X or PCIe controller.

Step 3113-1

Identify the adapter and disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, if the disk array member which corresponds to the **Degraded Disk S/N** has an **Actual Resource** of ***unkwn*** and is not physically present, it can be helpful to find this disk.
3. Go to "Step 3113-2."

Step 3113-2

Have the adapter or disks been physically moved recently?

No   Contact your hardware service provider.

Yes   Go to "Step 3113-3."

Step 3113-3

Perform only one of the following options, listed in the order of preference:

Option 1
>
> Restore the adapter and disks back to their original configuration. See "SAS resource locations" on page 107 to understand how to locate a disk using the **Expected Resource** and **Actual Resource** field.
>
> After restoring the adapter and disks to their original configuration, complete only one of the following steps:
>
> - Run diagnostics in system verification mode on the adapter:
>   1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2. Select **Run Diagnostics**.
>   3. Select the adapter resource.
>   4. Select **System Verification**.
> - Unconfigure and reconfigure the adapter by performing the following steps:
>   1. Unconfigure the adapter.
>   a. Start the IBM SAS Disk Array Manager.
>   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
>   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
>   2. Configure the adapter.
>   a. Start the IBM SAS Disk Array Manager.
>   1) Start Diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
>   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.
> - Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Delete the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

   a. Start Diagnostics and select **Task Selection** on the Function Selection display.

   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.

3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the remaining members of the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

   a. Start Diagnostics and select **Task Selection** on the Function Selection display.

   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3120

Use this MAP to resolve the following problem: Cache data associated with attached disks cannot be found (SRN *nnnn*-9010) for a PCI-X or PCIe controller.

Step 3120-1

Is the adapter connected in an HA RAID configuration (that is, two adapters connected to the same set of disks)?

No   Go to "Step 3120-2."

Yes   Contact your hardware service provider.

Step 3120-2

Has the server been powered off for several days?

No   Go to "Step 3120-3."

Yes   Go to "Step 3120-8" on page 127.

Step 3120-3

Are you working with a 572F/575C card set?

No   Go to "Step 3120-5" on page 126.

Yes   Go to "Step 3120-4" on page 126.

Step 3120-4

Note: Label all parts (original and new) before moving them.

Using the appropriate service procedures, remove the 572F/575C card set. Create and install the new card set that has the following parts installed on it:

- The new replacement 572F storage I/O adapter
- The cache directory card from the original 572F storage I/O adapter
- The original 575C auxiliary cache adapter

Note: See "Separating the 572F/575C card set and moving the cache directory card" on page 91 to locate the parts in the preceding list.

Go to "Step 3120-6."

Step 3120-5

Note: Label all parts (original and new) before moving them.

Using the appropriate service procedures, remove the I/O adapter. Install the new replacement storage I/O adapter with the following parts installed on it:

- The cache directory card from the original storage I/O adapter. See "Replacing the cache directory card" on page 95.
- The removable cache card from the original storage I/O adapter, if the original adapter contained a removable cache card. This applies only to certain adapters that have a removable cache card. Verify that the storage I/O adapter is listed in the feature comparison tables for PCIe and PCI-X cards as having Yes in the column for **Removable Cache Card**.

Step 3120-6

Has a new SRN of *nnnn*-9010 or *nnnn*-9050 occurred?

No   Go to "Step 3120-9" on page 127.

Yes   Go to "Step 3120-7."

Step 3120-7

Was the new SRN *nnnn*-9050?

No   The new SRN was *nnnn*-9010. Reclaim the controller cache storage as follows:

   Attention: Data might be lost. When an auxiliary cache adapter connected to the RAID controller logs a *nnnn* - 9055 SRN in the hardware error log, the reclaim process does not result in lost sectors. Otherwise, the reclaim process does result in lost sectors.

   1. Start the IBM SAS Disk Array Manager.
      a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.
   3. Confirm to proceed.

   Note: On the Reclaim Controller Cache Storage results display, the number of lost sectors is displayed. If the number is 0, there is no data loss. If the number is not 0, data has been lost and the system operator might want to restore data after this procedure is completed.

4. Go to "Step 3120-9."

Yes Contact your hardware service provider.

Step 3120-8

If the server has been powered off for several days after an abnormal power-down, the cache battery pack might be depleted. Do not replace the adapter or the cache battery pack. Reclaim the controller cache storage as follows:

Attention: Data might be lost. When an auxiliary cache adapter connected to the RAID controller logs a *nnnn* - 9055 SRN in the hardware error log, the reclaim process does not result in lost sectors. Otherwise, the reclaim process does result in lost sectors.

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.
3. Confirm to proceed.

   Note: On the Reclaim Controller Cache Storage results display, the number of lost sectors is displayed. If the number is 0, there is no data loss. If the number is not 0, data has been lost and the system operator might want to restore data after this procedure is completed.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3120-9

Are you working with a 572F/575C card set?

No Go to "Step 3120-11."

Yes Go to "Step 3120-10."

Step 3120-10

Note: Label all parts (original and new) before moving them.

Using the appropriate service procedures, remove the 572F/575C card set. Create and install the new card set that has the following parts installed on it:
- The new replacement 572F storage I/O adapter
- The cache directory card from the new replacement 572F storage I/O adapter
- The new 575C auxiliary cache adapter

Note: See the figure at "Separating the 572F/575C card set and moving the cache directory card" on page 91 to find the locations of the parts in the preceding list.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3120-11

Using the appropriate service procedures, remove the I/O adapter. Install the new replacement storage I/O adapter with the following parts installed on it:

- The cache directory card from the new storage I/O adapter. Refer to "Replacing the cache directory card" on page 95.
- The removable cache card from the new storage I/O adapter, if the new adapter contains a removable cache card. This applies only to certain adapters that have a removable cache card. Verify that the storage I/O adapter is listed in the feature comparison tables for PCIe and PCI-X cards as having Yes in the column for **Removable Cache Card**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3121

Use this MAP to resolve the following problem: RAID controller resources not available due to previous problems (SRN *nnnn*-9054) for a PCI-X or PCIe controller.

Step 3121-1

Remove any new or replacement disks that have been attached to the adapter, either using the SCSI and SCSI RAID Hot Plug Manager or by powering off the system.

Perform only one of the following options:

Option 1
Run diagnostics in system verification mode on the adapter:
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Option 2
Unconfigure and reconfigure the adapter by performing the following steps:
1. Unconfigure the adapter.
   a. Start the IBM SAS Disk Array Manager.
      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
2. Configure the adapter.
   a. Start the IBM SAS Disk Array Manager
      1) Start Diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

Option 3
Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3130

Use this MAP to resolve the following problem: Controller does not support function expected by one or more disk (SRN *nnnn* - 9008) for a PCI-X or PCIe controller.

The possible causes are:

- The adapter or disks have been physically moved or changed such that the adapter does not support a function which the disks require.
- The disks were last used under the IBM® i operating system.
- The disks were moved from a PCIe2 controller to a PCI-X or PCIe controller.

Step 3130-1

Identify the affected disks by examining the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks which are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** for each of these disks indicates the adapter to which the disk was last attached when it was operational. See "SAS resource locations" on page 107 for information about locating a disk using the **Resource** field.
3. Go to "Step 3130-2."

Step 3130-2

Have the adapter or disks been physically moved recently or were the disks previously used by the IBM i operating system?

No   Contact your hardware service provider.

Yes   Go to "Step 3130-3."

Step 3130-3

Perform only one of the following options, listed in the order of preference:

Option 1
   Restore the adapter and disks back to their original configuration. Complete only one of the following steps:
   - Run diagnostics in system verification mode on the adapter:
     1. Start Diagnostics and select **Task Selection** on the Function Selection display.
     2. Select **Run Diagnostics**.
     3. Select the adapter resource.
     4. Select **System Verification**.
   - Unconfigure and reconfigure the adapter by performing the following steps:
     1. Unconfigure the adapter:
        a. Start the IBM SAS Disk Array Manager.
           1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
           2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
        b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
     2. Configure the adapter:
        a. Start the IBM SAS Disk Array Manager.
           1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
           2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

   b. Select **Diagnostics and Recovery OptionsConfigure a Defined IBM SAS RAID Controller**.
  • Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Format the disks, as follows:

Attention: All data on the disk array will be lost.
1. Start the IBM SAS Disk Array Manager.
 a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
 b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3131

Use this MAP to resolve the following problem: Required cache data cannot be located for one or more disks (SRN *nnnn*-9050) for a PCI-X or PCIe controller.

Step 3131-1

Did you just exchange the adapter as the result of a failure?

No Go to "Step 3131-6" on page 131.

Yes Go to Step "Step 3131-2."

Step 3131-2

Is the adapter connected in an HA RAID configuration (that is, two adapters connected to the same set of disks)?

No Go to "Step 3131-3."

Yes Contact your hardware service provider.

Step 3131-3

Are you working with a 572F/575C card set?

No Go to "Step 3131-5" on page 131.

Yes Go to Step "Step 3131-4."

Step 3131-4

Note: Label all parts (original and new) before moving them.

Using the appropriate service procedures, remove the 572F/575C card set. Create and install the new card set that has the following parts installed on it:
• The new replacement 572F storage I/O adapter
• The cache directory card from the original 572F storage I/O adapter

- The original 575C auxiliary cache adapter

Note: See the figures at "Separating the 572F/575C card set and moving the cache directory card" on page 91 to locate the relevant parts of the card.

Step 3131-5

Notes:

1. The failed adapter that you have just exchanged contains cache data that is required by the disks that were attached to that adapter. If the adapter that you just exchanged is failing intermittently, reinstalling it and IPLing the system might allow the data to be successfully written to the disks. After the cache data is written to the disks and the system is powered off normally, the adapter can be replaced without data being lost. Otherwise, continue with this procedure.
2. Label all parts (old and new) before moving them.

Using the appropriate service procedures, remove the I/O adapter. Install the new replacement storage I/O adapter with the following parts installed on it:

- The cache directory card from the original storage I/O adapter. See the figures at "Replacing the cache directory card" on page 95 to identify the relevant locations on the card.
- The removable cache card from the original storage I/O adapter, if the original storage I/O adapter has a removable cache card. Verify that the storage I/O adapter is listed in the feature comparison tables for PCIe and PCI-X cards as having Yes in the **Removable Cache Card** column.

Step 3131-6

Identify the affected disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks which are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** for each of these disks indicates the adapter to which the disk was last attached when it was operational. Refer to "SAS resource locations" on page 107 to understand how to locate a disk using the **Resource** field.
3. Go to "Step 3131-7."

Step 3131-7

Have the adapter or disks been physically moved recently?

No   Contact your hardware service provider

Yes   Go to "Step 3131-8"

Step 3131-8

Is the data on the disks needed for this or any other system?

No   Go to "Step 3131-10" on page 132

Yes   Go to "Step 3131-9"

Step 3131-9

The adapter and disks, identified previously, must be reunited so that the cache data can be written to the disks.

Restore the adapter and disks back to their original configuration. Once the cache data is written to the disks and the system is powered off normally, the adapter and/or disks can be moved to another location.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3131-10

Perform only one of the following options, listed in the order of preference:

Option 1

Reclaim controller cache storage by performing the following steps:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.

3. Confirm to **Allow Unknown Data Loss**.

4. Confirm to proceed.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

If the disks are members of a disk array, delete the disk array by doing the following steps:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager as follows:

    a. Start Diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.

3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the disks, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager as follows:

    a. Start Diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3131-11

Has a new SRN *nnnn*-9010 or *nnnn*-9050 occurred?

No   Go to "Step 3131-13"

Yes   Go to "Step 3131-12"

Step 3131-12

Was the new SRN *nnnn*-9050?

No   The new SRN was *nnnn*-9010.

Reclaim the controller cache storage as follows:

Attention: Data might be lost. When an auxiliary cache adapter connected to the RAID controller logs an *nnnn* - 9055 SRN in the hardware error log, the reclaim process does not result in lost sectors. Otherwise, the reclaim process does result in lost sectors.

1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.
3. Confirm to proceed.

   Note: On the Reclaim Controller Cache Storage results display, the number of lost sectors is displayed. If the number is 0, there is no data loss. If the number is not 0, data has been lost and the system operator might want to restore data after this procedure is completed.
4. Go to "Step 3131-13"

Yes   Contact your hardware service provider.

Step 3131-13

Are you working with a 572F/575C card set?

No   Go to "Step 3131-15" on page 134

Yes   Go to "Step 3131-14"

Step 3131-14

Note: Label all parts (original and new) before moving them.

Using the appropriate service procedures, remove the 572F/575C card set. Create and install the new card set that has the following parts installed on it:
- The new 572F storage I/O adapter
- The cache directory card from the new replacement 572F storage I/O adapter
- The new 575C auxiliary cache adapter

Note: See the figures at "Separating the 572F/575C card set and moving the cache directory card" on page 91 to locate the parts appearing in the preceding list.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3131-15

Using the appropriate service procedures, remove the I/O adapter. Install the new replacement storage I/O adapter with the following parts installed on it:

- The cache directory card from the new storage I/O adapter. Refer to "Replacing the cache directory card" on page 95.
- The removable cache card from the new storage I/O adapter. This only applies to certain adapters which have a removable cache card. Verify that the storage I/O adapter is listed in the feature comparison tables for PCI Express and PCI-X cards as having Yes in column for **Removable Cache Card**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3132

Use this MAP to resolve the following problem: Cache data exists for one or more missing or failed disks (SRN *nnnn*-9051) for a PCI-X or PCIe controller.

The possible causes follow:

- One or more disks have failed on the adapter.
- One or more disks were either moved concurrently or were removed after an abnormal power off.
- The adapter was moved from a different system or a different location on this system after an abnormal power off.
- The cache of the adapter was not cleared before it was shipped to the customer.

Step 3132-1

Identify the affected disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks which are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** for each of these disks indicates the adapter to which the disk was last attached when it was operational. See "SAS resource locations" on page 107 to understand how to locate a disk using the Resources field.
3. Go to "Step 3132-2."

Step 3132-2

Are there other disk or adapter errors that have occurred at approximately the same time as this error?

No   Go to "Step 3132-3."

Yes   Go to "Step 3132-6" on page 135.

Step 3132-3

Is the data on the disks (and thus the cache data for the disks) needed for this or any other system?

No   Go to "Step 3132-7" on page 135.

Yes   Go to "Step 3132-4."

Step 3132-4

Have the adapter card or disks been physically moved recently?

No   Contact your hardware service provider.

Yes   Go to "Step 3132-5."

Step 3132-5

The adapter and disks must be reunited so that the cache data can be written to the disks.

Restore the adapter and disks back to their original configuration.

After the cache data is written to the disks and the system is powered off normally, the adapter or disks can be moved to another location.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3132-6

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3132-7

Reclaim the Controller Cache Storage by performing the following steps:

Attention: Data will be lost.
1. Start the IBM SAS Disk Array Manager.
    a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.
3. Confirm to **Allow Unknown Data Loss**.
4. Confirm to proceed.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3133

Use this MAP to resolve the following problems:
- Disk has been modified after last known status (SRN *nnnn*-9090) for a PCI-X or PCIe controller.
- Incorrect disk configuration change has been detected (SRN *nnnn*-9091) for a PCI-X or PCIe controller.

Step 3133-1

Perform only one of the following options:

Option 1

Run diagnostics in system verification mode on the adapter:

1. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Option 2

Unconfigure and reconfigure the adapter by performing the following steps:

1. Unconfigure the adapter.
   a. Start the IBM SAS Disk Array Manager.
      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
2. Configure the adapter.
   a. Start the IBM SAS Disk Array Manager.
      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

Option 3

Perform an IPL of the system or logical partition:

Step 3133-2

Take action on any other errors which are now occurring.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3134

Use this MAP to resolve the following problem: Disk requires Format before use (SRN nnnn-9092) for a PCI-X or PCIe controller

The possible causes follow:

- Disk is a previously failed disk from a disk array and was automatically replaced by a hot spare disk.
- Disk is a previously failed disk from a disk array and was removed and later reinstalled on a different adapter or different location on this adapter.
- Appropriate service procedures were not followed when replacing disks or reconfiguring the adapter, such as not using the SCSI and SCSI RAID Hot Plug Manager when concurrently removing or installing disks, or not performing a normal power off of the system prior to reconfiguring disks and adapters.
- Disk is a member of a disk array, but was detected subsequent to the adapter being configured.
- Disk has multiple or complex configuration problems.

Step 3134-1

Identify the affected disks by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks that are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** for each of these disks indicates the adapter to which the disk was last attached when it was operational. Refer to "SAS resource locations" on page 107 to understand how to locate a disk using the **Resource** field.
3. Go to "Step 3134-2."

Step 3134-2

Are there other disk or adapter errors that have occurred at about the same time as this error?

No   Go to "Step 3134-3."

Yes   Go to "Step 3134-5."

Step 3134-3

Have the adapter card or disks been physically moved recently?

No   Go to "Step 3134-4."

Yes   Go to "Step 3134-6."

Step 3134-4

Is the data on the disks needed for this or any other system?

No   Go to "Step 3134-7" on page 139.

Yes   Go to "Step 3134-6."

Step 3134-5

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3134-6

Perform only one of the following options that is most applicable to your situation:

Option 1

> Perform only one of the following to cause the adapter to rediscover the disks and then take action on any new errors:
> - Run diagnostics in system verification mode on the adapter
>   1. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
>   2. Select **Run Diagnostics**.
>   3. Select the adapter resource.
>   4. Select **System Verification**.
> - Unconfigure and reconfigure the adapter by performing the following steps:
>   1. Unconfigure the adapter.

a. Start the IBM SAS Disk Array Manager.

1) Start Diagnostics and select **Task Selection** on the Function Selection display.

2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

2. Configure the adapter.

a. Start the IBM SAS Disk Array Manager.

1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

• Perform an IPL on the system or logical partition

Take action on any other errors which are now occurring.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Restore the adapter and disks to their original configuration. Once this has been done, complete only one of the following options:

• Run diagnostics in system verification mode on the adapter

1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

2. Select **Run Diagnostics**.

3. Select the adapter resource.

4. Select **System Verification**.

• Unconfigure and reconfigure the adapter by performing the following steps:

1. Unconfigure the adapter.

a. Start the IBM SAS Disk Array Manager.

1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

2. Configure the adapter.

a. Start the IBM SAS Disk Array Manager.

1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

• Perform an IPL of the system or logical partition

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Remove the disks from this adapter.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3134-7

Perform only one of the following options.

Option 1

> If the disks are members of a disk array, delete the disk array by doing the following steps:
>
> **Attention:** All data on the disk array will be lost.
>
> **Note:** In some rare scenarios, deleting the disk array will not have any effect on a disk and the disk must be formatted instead.
>
> 1. Start the IBM SAS Disk Array Manager.
>   a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
>   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
> 2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
> 3. Select the disk array to delete.
>
> When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

> Do the following to format the disks:
>
> **Attention:** All data on the disks will be lost.
>
> 1. Start the IBM SAS Disk Array Manager.
>   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
> 2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.
>
> When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3135

Use this MAP to resolve the following problem: Disk media format bad (SRN nnnn-FFF3) for a PCI-X or PCIe controller.

The possible causes follow:
- Disk was being formatted and was powered off during this process.
- Disk was being formatted and was reset during this process.

Step 3135-1

Identify the affected disk by examining the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, under the **Disk Information** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for the disk. See "SAS resource locations" on page 107 to understand how to locate a disk using the **Resource** field.
3. Go to "Step 3135-2."

Step 3135-2

Format the disk by doing the following steps:

Attention: All data on the disks will be lost.

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3140

Use this MAP to resolve the following problem: Multiple controllers connected in an invalid configuration (SRN *nnnn* - 9073) for a PCI-X or PCIe controller.

The possible causes follow:
- Incompatible adapters are connected to each other. Such an incompatibility includes invalid adapter combinations such as the following situations. See the feature comparison tables for PCIe and PCI-X cards for a list of the supported adapters and their attributes.
  - An adapter is CCIN 572A but has a part number of either 44V4266 or 44V4404 (feature code 5900), which does not support multi-initiator and high availability
  - Adapters with different write cache sizes
  - One adapter is not supported by AIX
  - An adapter that does not support auxiliary cache is connected to an auxiliary cache adapter
  - An adapter that supports multi-initiator and high availability is connected to another adapter which does not have the same support
  - Adapters connected for multi-initiator and high availability are not both operating in the same **Dual Initiator Configuration**, for example both are not set to **Default** or both are not set to **JBOD HA Single Path**.
  - Greater than 2 adapters are connected for multi-initiator and high availability
  - Adapter microcode levels are not up to date or are not at the same level of functionality
- One adapter, of a connected pair of adapters, is not operating under the AIX operating system. Connected adapters must both be controlled by AIX. Additionally, both adapters must be in the same system partition if one adapter is an auxiliary cache adapter.
- Adapters connected for multi-initiator and high availability are not cabled correctly. Each type of high availability configuration requires specific cables be used in a supported manner.

Step 3140-1

Determine which of the possible causes applies to the current configuration and take the appropriate actions to correct it. If this does not correct the error, contact your hardware service provider.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3141

Use this MAP to resolve the following problem: Multiple controllers not capable of similar functions or controlling same set of devices (SRN nnnn-9074) for a PCI-X or PCIe controller.

Step 3141-1

This error relates to adapters connected in a Multi Initiator and High Availability configuration. To obtain the reason or description for this failure, you must find the formatted error information in the AIX error log. This should also contain information about the attached adapter (**Remote Adapter** fields).

Display the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Select the hardware error log to view. Viewing the hardware error log, the **Detail Data** section contains the **REASON FOR FAILURE** and the **Remote Adapter Vendor ID**, **Product ID**, **Serial Number**, and **World Wide ID**.

3. Go to "Step 3141-2."

Step 3141-2

Find the **REASON FOR FAILURE** and information for the attached adapter (remote adapter) shown in the error log, and perform the action listed for the reason in the following table:

Table 16. RAID array reason for failure

Reason for Failure	Description	Action	Adapter on which to perform the action
The secondary adapter does not support RAID level being used by the primary adapter.	The secondary adapter detected that the primary adapter has a RAID array with a RAID level that the secondary adapter does not support.	The customer needs to upgrade the type of secondary adapter or change the RAID level of the array on the primary adapter to a level that is supported by the secondary adapter.	Physically change the type of adapter that logged the error. Change RAID level on primary adapter (remote adapter indicated in the error log).
The secondary adapter does not support disk function being used by the primary adapter.	The secondary adapter detected a device function that it does not support.	The customer might need to upgrade the adapter microcode or upgrade the type of secondary adapter.	Adapter that logged the error.
The secondary adapter is unable to find devices found by the primary adapter.	The secondary adapter cannot discover all the devices that the primary adapter has.	Verify the connections to the devices from the adapter logging the error. View the disk array configuration screens to determine the SAS port with the problem.	Adapter that logged the error.
The secondary adapter found devices not found by the primary adapter.	The secondary adapter has discovered more devices than the primary adapter. After this error is logged, an automatic failover will occur.	Verify the connections to the devices from the remote adapter as indicated in the error log. View the disk array configuration screens to determine the SAS port with the problem.	Remote adapter indicated in the error log.
The secondary adapter port not connected to the same numbered port on the primary adapter.	SAS connections from the adapter to the devices are incorrect. Common disk expansion drawers must be attached to the same numbered SAS port on both adapters.	Verify connections and recable SAS connections as necessary.	Either adapter.
The primary adapter lost contact with disks accessible by the secondary adapter.	Link failure from primary adapter to devices. An automatic failover will occur.	Verify cable connections from the adapter which logged the error. Possible disk expansion drawer failure.	Adapter that logged the error.

Table 16. RAID array reason for failure (continued)

Reason for Failure	Description	Action	Adapter on which to perform the action
Other		Contact your hardware service provider.	

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3142

Use this MAP to resolve the following problem:

Configuration error: incorrect connection between cascaded enclosures (SRN *nnnn*-4010) for a PCI-X or PCIe controller.

The possible causes follow:
- Incorrect cabling of cascaded device enclosures.
- Use of an unsupported device enclosure.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3142-1

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the **Resource** field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

        ^

        |

    Resource is 0004FFFF
```

Using the resource found in step 2, see "SAS resource locations" on page 107 to understand how to identify the controller's port to which the device, or device enclosure, is attached.

For example, if the resource is 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure, that is experiencing the problem.

Step 3142-2

Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial attached SCSI cable planning.

If unsupported device enclosures are attached, then either remove or replace them with supported device enclosures.

Step 3142-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error reoccur?

No Go to "Step 3142-4."

Yes Contact your hardware service provider.

Step 3142-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3143

Use this MAP to resolve the following problem: Configuration error, connections exceed controller design limits (SRN *nnnn* – 4020) for a PCI-X or PCIe controller.

The possible causes follow:

- Unsupported number of cascaded device enclosures.
- Improper cabling of cascaded device enclosures.

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3143-1

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the Resource field from the `Detail Data / PROBLEM DATA` section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

         ^

         |

     Resource is 0004FFFF
```

Using the Resource found in the previous step, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the Resource were equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3143-2

Reduce the number of cascaded device enclosures. Device enclosures might only be cascaded one level deep, and only in certain configurations.

Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3143-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error reoccur?

No   Go to "Step 3143-4."

Yes   Contact your hardware service provider.

Step 3143-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3144

Use this MAP to resolve the following problems:
- Configuration error, incorrect multipath connection (SRN *nnnn* – 4030) for a PCI-X or PCIe controller
- Configuration error, incomplete multipath connection between controller and enclosure detected (SRN nnnn-4040) for a PCI-X or PCIe controller

The possible causes are:
- Incorrect cabling to device enclosure.

  Note: Pay special attention to the requirement that a Y0-cable, YI-cable, or X-cable must be routed along the right side of the rack frame (as viewed from the rear) when connecting to a disk expansion drawer. Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial attached SCSI cable planning.
- A failed connection caused by a failing component in the SAS fabric between, and including, the controller and device enclosure.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have SAS and PCI-X or PCIe bus interface logic integrated onto the system boards and use a pluggable RAID Enablement Card (a non-PCI form factor card) for these integrated buses. See

the feature comparison tables for PCIe and PCI-X cards. For these configurations, replacement of the RAID Enablement Card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board.

- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.

- Some systems have SAS RAID adapters integrated onto the system boards and use a Cache RAID - Dual IOA Enablement Card (for example, FC5662) to enable storage adapter Write Cache and Dual Storage IOA (HA RAID mode). For these configurations, replacement of the Cache RAID - Dual IOA Enablement Card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board. Additionally, appropriate service procedures must be followed when replacing the Cache RAID - Dual IOA Enablement Card because removal of this card can cause data loss if incorrectly performed and can also result in a non-Dual Storage IOA (non-HA) mode of operation.

- Some configurations involve a SAS adapter connecting to internal SAS disk enclosures within a system using a FC3650 or FC3651 cable card. Keep in mind that when the MAP refers to an device enclosure, it could be referring to the internal SAS disk slots or media slots. Also, when the MAP refers to a cable, it could include a FC3650 or FC3651 cable card.

- Some adapters, known as RAID and SSD adapters, contain SSDs, which are integrated on the adapter. See the feature comparison tables for PCIe cards. For these configurations, FRU replacement to solve SAS-related problems is limited to replacing either the adapter or the integrated SSDs because the entire SAS interface logic is contained on the adapter.

- When using SAS adapters in either an HA two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the Primary adapter and not the Secondary adapter.

- Before executing the system verification action in this map, reconstruct any degraded disk arrays if possible. This will help avoid potential data loss resulting from the adapter reset performed during system verification action taken in this map.

Attention: Obtain assistance from your Hardware Service Support organization before you replace RAID adapters when SAS fabric problems exist. Because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, additional problems might be created by replacing an adapter when SAS fabric problems exist. Appropriate service procedures must be followed when replacing the Cache RAID - Dual IOA Enablement Card (for example, FC5662) because removal of this card can cause data loss if incorrectly performed and can also result in a non-Dual Storage IOA (non-HA) mode of operation.

Step 3144-1

Was the SRN *nnnn*-4030?

No   Go to "Step 3144-5" on page 146.

Yes   Go to "Step 3144-2."

Step 3144-2

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Obtain the Resource field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA
```

```
0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

       ^

       |

   Resource is 0004FFFF
```

Using the Resource found in the previous step, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the Resource were equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure, which is experiencing the problem.

Step 3144-3

Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see "Serial attached SCSI cable planning.

Step 3144-4

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error reoccur?

No   Go to "Step 3144-10" on page 148.

Yes   Contact your hardware service provider.

Step 3144-5

The SRN is *nnnn*-4040.

Determine if a problem still exists for the adapter that logged this error by examining the SAS connections as follows:
1. Start the IBM SAS Disk Array Manager.
    a. Start Diagnostics and select **Task Selection** on the Function Selection screen.
    b. Select **RAID Array Manager**.
    c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options.**
3. Select **Show SAS Controller Physical Resources.**
4. Select **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as Operational?

No   Go to "Step 3144-6" on page 147.

Yes   Go to "Step 3144-10" on page 148.

Step 3144-6

Run diagnostics in System Verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: At this point, ignore any problems found and continue with the next step.

Step 3144-7

Determine if the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options.**
3. Select **Show SAS Controller Physical Resources.**
4. Select **Show Fabric Path Graphical View**.
5. Select a device with a path which is not **Operational** (if one exists) to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3144-8."

Yes Go to "Step 3144-10" on page 148.

Step 3144-8

After the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the corrective actions listed below, which are listed in the order of preference. If one of the corrective actions has previously been attempted, then proceed to the next one in the list.

   Note: Prior to replacing parts, consider using a complete shutdown and power off of the entire system, including any external device enclosures, to provide a reset of all possible failing components. This might correct the problem without replacing parts.
   - Reseat cables on adapter and device enclosure.
   - Replace cable from adapter to device enclosure.
   - Replace the internal device enclosure or see the service documentation for an external expansion drawer to determine what FRU to replace which may contain the SAS expander.
   - Replace the adapter.
   - Contact your hardware service provider.
3. Power on the system or logical partition.

Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3144-9

Determine if the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options.**
3. Select **Show SAS Controller Physical Resources.**
4. Select **Show Fabric Path Graphical View**.
5. Select a device with a path that is not **Operational** (if one exists) to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3144-8" on page 147.

Yes   Go to "Step 3144-10."

Step 3144-10

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3145

Use this MAP to resolve the following problem: Unsupported enclosure function detected (SRN nnnn-4110) for a PCI-X or PCIe controller.

The possible causes follow:
- Device enclosure or adapter microcode levels are not up to date.
- Unsupported type of device enclosure or device.

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3145-1

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the Resource field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA
```

```
0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

        ^

        |

   Resource is 0004FFFF
```

Using the Resource found in the previous step, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the Resource were equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure, which is experiencing the problem.

Step 3145-2

Ensure device enclosure or adapter microcode levels are up to date.

If unsupported device enclosures or devices are attached, then either remove or replace them with supported device enclosures or devices.

Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3145-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error reoccur?

No   Go to "Step 3145-4."

Yes   Contact your hardware service provider.

Step 3145-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3146

Use this MAP to resolve the following problem: Configuration error, incomplete multipath connection between enclosures and device detected (SRN *nnnn* - 4041) for a PCI-X or PCIe controller.

The possible cause is a failed connection caused by a failing component within the device enclosure, including the device itself.

Note: The adapter is not a likely cause of this problem.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- Some configurations involve a SAS adapter connecting to internal SAS disk enclosures within a system using a FC3650 or FC3651 cable card. Keep in mind that when the MAP refers to an device enclosure, it could be referring to the internal SAS disk slots or media slots. Also, when the MAP refers to a cable, it could include a FC3650 or FC3651 cable card.
- When using SAS adapters in either an HA two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the Primary adapter and not the Secondary adapter.
- Before executing the system verification action in this map, reconstruct any degraded disk arrays if possible. This will help avoid potential data loss resulting from the adapter reset performed during system verification action taken in this map.

Attention: Removing functioning disks in a disk array is not recommended without assistance from your Hardware Service Support organization. A disk array might become degraded or failed if functioning disks are removed and additional problems might be created.

Step 3146-1

Determine if a problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as `Operational`?

No Go to "Step 3146-2."

Yes Go to "Step 3146-6" on page 152.

Step 3146-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: At this point, disregard any problems found, and continue with the next step.

Step 3146-3

Determine if the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

3. Select a device with a path that is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

Yes Go to "Step 3146-6" on page 152.

No Go to "Step 3146-4."

Step 3146-4

Because the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions has been attempted, then proceed to the next action in the list.

   Note: Prior to replacing parts, consider using a complete shutdown to power off the entire system, including any external device enclosures, to provide a reset of all possible failing components. This action might correct the problem without replacing parts.

   - Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial-attached SCSI cable planning.
   - Reseat the cables on the adapter, on the device enclosure, and between cascaded enclosures if present.
   - Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
   - Replace the internal device enclosure or refer to the service documentation for an external expansion drawer to determine what FRU to replace which may contain the SAS expander.
   - Replace the device.
   - Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3146-5

Determine if the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No Go to "Step 3146-4."

Yes   Go to "Step 3146-6."

Step 3146-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3147

Use this MAP to resolve the following problem: Missing remote controller (SRN nnnn-9076) for a PCI-X or PCIe controller.

Step 3147-1

An adapter attached in either an auxiliary cache or multi initiator and high availability configuration was not discovered in the allotted time. To obtain additional information about the configuration involved, locate the formatted error information in the AIX error log.

Display the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, the **Detail Data** section contains the **Link Type** that describes the configuration. If the **Link Type** is **AWC** then an auxiliary cache configuration is involved. If the **Link Type** is **HA** then a multi-initiator and high availability configuration is involved.
3. Go to "Step 3147-2."

Step 3147-2

Determine which of the following is the cause of your specific error and take the appropriate actions listed. If this does not correct the error, contact your hardware service provider.

The possible causes are:
- An attached adapter for the configuration is not installed or is not powered on. Some adapters are required to be part of an HA RAID configuration. Verify this requirement in the feature comparison tables for PCIe and PCI-X cards. Ensure that both adapters are properly installed and powered on.
- If this is an Auxiliary Cache or HA single-system RAID configuration, then both adapters might not be in the same partition. Ensure that both adapters are assigned to the same partition.
- An attached adapter does not support the desired configuration. Verify whether such configuration support exists by reviewing the the feature comparison tables for PCIe and PCI-X cards to see whether the entries for Auxiliary write cache (AWC) support, HA two-system RAID, HA two-system JBOD, or HA single-system RAID support have Yes in the column for the desired configuration.
- An attached adapter for the configuration is failed. Take action on the other errors that have occurred at the same time as this error.
- Adapter microcode levels are not up to date or are not at the same level of functionality. Ensure that the microcode for both adapters is at the latest level.

Note: The adapter that is logging this error will run in a performance degraded mode, without caching, until the problem is resolved.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3148

Use this MAP to resolve the following problem: Attached enclosure does not support required multipath function (SRN *nnnn* – 4050) for a PCI-X or PCIe controller.

The possible cause is the use of an unsupported device enclosure.

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3148-1

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the Resource field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

        ^

        |

      Resource is 0004FFFF
```

Using the Resource found in the previous step, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the Resource were equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure, which is experiencing the problem.

Step 3148-2

If unsupported device enclosures are attached, then either remove or replace them with supported device enclosures.

Step 3148-3

Run diagnostics in System Verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error recur?

No   Go to "Step 3148-4" on page 154.

Yes   Contact your hardware service provider.

Step 3148-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3149

Use this MAP to resolve the following problem: Incomplete multipath connection between controller and remote controller (SRN *nnnn* - 9075) for a PCI-X or PCIe controller.

The possible cause is incorrect cabling between SAS RAID controllers.

Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3149-1

Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3149-2

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3150

Use the following to perform SAS fabric problem isolation for a PCI-X or PCIe controller.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have SAS and PCI-X or PCIe bus interface logic integrated onto the system boards and use a pluggable RAID enablement card (a non-PCI form factor card) for these integrated-logic buses, See the feature comparison tables for PCIe and PCI-X cards. For these configurations, replacement of the RAID enablement card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board.
- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- Some systems have SAS RAID adapters integrated onto the system boards and use a Cache RAID - Dual IOA Enablement Card (for example, FC5662) to enable storage adapter Write Cache and Dual Storage IOA (HA RAID mode). For these configurations, replacement of the Cache RAID - Dual IOA Enablement Card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board. Additionally, appropriate service procedures must be followed when replacing the Cache RAID - Dual IOA Enablement Card because removal of this card can cause data loss if incorrectly performed and can also result in a non-Dual Storage IOA (non-HA) mode of operation.
- Some adapters, known as RAID and SSD adapters, contain SSDs, which are integrated on the adapter. See the feature comparison tables for PCIe cards. For these configurations, FRU replacement to solve SAS-related problems is limited to replacing either the adapter or the integrated SSDs because the entire SAS interface logic is contained on the adapter.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, and additional problems might be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array because the disk array might become degraded or might fail, and additional problems might be created if functioning disks are removed from a disk array.

Attention: Removing functioning disks in a disk array is not recommended without assistance from your hardware service support organization. A disk array might become degraded or might fail if functioning disks are removed, and additional problems might be created.

Step 3150-1

Was the SRN *nnnn*-3020 or SRN *nnnn*-FFFE?

No   Go to "Step 3150-3."

Yes   Go to "Step 3150-2."

Step 3150-2

The possible causes for SRN *nnnn*-3020 are:
- More devices are connected to the adapter than the adapter supports. Change the configuration to reduce the number of devices below what is supported by the adapter.
- A SAS device has been improperly moved from one location to another. Either return the device to its original location or move the device while the adapter is powered off or unconfigured.
- A SAS device has been improperly replaced by a SATA device. A SAS device must be used to replace a SAS device.

The possible causes for SRN *nnnn*-FFFE are:
- One or more SAS devices were moved from a PCIe2 controller to a PCI-X or PCIe controller. If the device was moved from a PCIe2 controller to a PCI-X or PCIe controller, the Detail Data section of the hardware error log contains a reason for failure of `Payload CRC Error`. For this case, the error can be ignored and the problem is resolved if the devices are moved back to a PCIe2 controller or if the devices are formatted on the PCI-X or PCIe controller.
- For all other causes, Go to "Step 3150-3"

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3150-3

Determine if any of the disk arrays on the adapter are in a **Degraded** state as follows:
1. Start the IBM SAS Disk Array Manager.
    a. Start Diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration** > **IBM SAS RAID Controller**.
3. Select the identified in the hardware error log.

Does any disk array have a state of **Degraded**?

No   Go to "Step 3150-5" on page 156.

Yes Go to "Step 3150-4."

Step 3150-4

Other errors should have occurred related to the disk array being in a **Degraded** state. Take action on these errors to replace the failed disk and restore the disk array to an **Optimal** state.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3150-5

Have other errors occurred at the same time as this error?

No Go to "Step 3150-7."

Yes Go to "Step 3150-6."

Step 3150-6

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3150-7

Was the SRN *nnnn*-FFFE?

No Go to "Step 3150-10."

Yes Go to "Step 3150-8."

Step 3150-8

Ensure device, device enclosure, and adapter microcode levels are up to date.

Did you update to newer microcode levels?

No Go to "Step 3150-10."

Yes Go to "Step 3150-9."

Step 3150-9

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3150-10

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. Viewing the hardware error log, under the **Disk Information** heading, the **Resource** field can be used to identify which controller port the error is associated with.

Note: If you do not see the **Disk Information** heading in the error log, obtain the Resource field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0000 0800 0004 FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 0408 0100 0101 0000

          ^

          |

      Resource is 0004FFFF
```

Go to "Step 3150-11."

Step 3150-11

Using the *resource* found in the previous step, see "SAS resource locations" on page 107 to understand how to identify the controller's port to which the device, or device enclosure, is attached.

For example, if the resource were equal to 0004FFFF, port 04 on the adapter is used to attach the device, or device enclosure that is experiencing the problem.

The resource found in the previous step can also be used to identify the device. To identify the device, you can attempt to match the Rresource with one found on the display, which is displayed by completing the following steps.

1. Start the IBM SAS Disk Array Manager:
    a. Start the diagnostics program and select **Task Selection** from the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Physical Resource Locations**.

Step 3150-12

Because the problem persists, some corrective action is needed to resolve the problem. Using the port or device information found in the previous step, proceed by doing the following steps.

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions has been attempted, then proceed to the next action in the list.

    Note: Prior to replacing parts, consider using a complete power down of the entire system, including any external device enclosures, to reset all possible failing components. This might correct the problem without replacing parts.
    - Reseat the cables on the adapter and the device enclosure.
    - Replace the cable from the adapter to the device enclosure.
    - Replace the device.

        Note: If there are multiple devices with a path that is not marked as **Operational**, then the problem is not likely to be with a device.
    - Replace the internal device enclosure or refer to the service documentation for an external expansion drawer.
    - Replace the adapter.
    - Contact your hardware service provider.
3. Power on the system or logical partition.

Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3150-13

Does the problem still occur after performing the corrective action?

No Go to "Step 3150-14."

Yes Go to "Step 3150-12" on page 157.

Step 3150-14

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3152

Use this MAP to resolve the following problems:
* Device bus fabric error (SRN *nnnn* - 4100) for a PCI-X or PCIe controller.
* Temporary device bus fabric error (SRN *nnnn* - 4101) for a PCI-X or PCIe controller.

The possible causes follow:
* A failed connection caused by a failing component in the SAS fabric between, and including, the adapter and device enclosure.
* A failed connection caused by a failing component within the device enclosure, including the device itself.

Considerations:
* Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
* Some systems have SAS and PCI-X or PCIe bus interface logic integrated onto the system boards and use a pluggable RAID enablement card (a non-PCI form factor card) for such integrated-logic buses. See the feature comparison tables for PCIe and PCI-X cards. For these configurations, replacement of the RAID enablement card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board.
* Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
* Some systems have SAS RAID adapters integrated onto the system boards and use a Cache RAID - Dual IOA Enablement Card (e.g. FC5662) to enable storage adapter Write Cache and Dual Storage IOA (HA RAID mode). For these configurations, replacement of the Cache RAID - Dual IOA Enablement Card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board. Additionally, appropriate service procedures must be followed when replacing the Cache RAID - Dual IOA Enablement Card since removal of this card can cause data loss if incorrectly performed and can also result in a non-Dual Storage IOA (non-HA) mode of operation.
* Some configurations involve a SAS adapter connecting to internal SAS disk enclosures within a system using a FC3650 or FC3651 cable card. Keep in mind that when the MAP refers to an device enclosure, it could be referring to the internal SAS disk slots or media slots. Also, when the MAP refers to a cable, it could include a FC3650 or FC3651 cable card.
* Some adapters, known as RAID and SSD adapters, contain SSDs, which are integrated on the adapter. See the feature comparison tables for PCIe cards. For these configurations, FRU replacement to solve SAS-related problems is limited to replacing either the adapter or the integrated SSDs because the entire SAS interface logic is contained on the adapter.

- When using SAS adapters in either an HA two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the Primary adapter (not the Secondary adapter).
- Before executing the system verification action in this map, reconstruct any degraded disk arrays if possible. This will help avoid potential data loss resulting from the adapter reset performed during system verification action taken in this map.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter; because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array; because the disk array might become degraded or failed and additional problems might be created if functioning disks are removed from a disk array.

Step 3152-1

Determine whether the problem still exists for the adapter which logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3152-2."

Yes   Go to "Step 3152-6" on page 161.

Step 3152-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: Disregard any trouble found for now, and continue with the next step.

Step 3152-3

Determine whether the problem still exists for the adapter which logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3152-4."

Yes   Go to "Step 3152-6" on page 161.

Step 3152-4

Because the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the corrective actions listed below, which are listed in the order of preference. If one of the corrective actions has previously been attempted, then proceed to the next one in the list.

   Note: Prior to replacing parts, consider doing a power off of the entire system, including any external device enclosures, to provide a reset of all possible failing components. This might correct the problem without replacing parts.

   • Reseat the cables on the adapter, on the device enclosure, and between cascaded enclosures if present.
   • Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
   • Replace the device.

   Note: If there are multiple devices with a path that is not marked as **Operational**, then the problem is not likely to be with a device.

   • Replace the internal device enclosure or refer to the service documentation for an external expansion drawer to determine what FRU to replace which may contain the SAS expander.
   • Replace the adapter.
   • Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3152-5

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3152-4" on page 160.

Yes   "Step 3152-6."

Step 3152-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3153

Use this MAP to resolve the following problem: Multipath redundancy level got worse (SRN *nnnn* - 4060) for a PCI-X or PCIe controller.

The possible causes follow:
- A failed connection caused by a failing component in the SAS fabric between, and including, the adapter and device enclosure.
- A failed connection caused by a failing component within the device enclosure, including the device itself.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have SAS and PCI-X or PCIe bus interface logic integrated onto the system boards and use a pluggable RAID enablement card (a non-PCI form factor card) for such integrated-logic buses. See the feature comparison tables for PCIe and PCI-X cards. For these configurations, replacement of the RAID enablement card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board.
- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- Some systems have SAS RAID adapters integrated onto the system boards and use a Cache RAID - Dual IOA Enablement Card (for example, FC5662) to enable storage adapter Write Cache and Dual Storage IOA (HA RAID mode). For these configurations, replacement of the Cache RAID - Dual IOA Enablement Card is unlikely to solve a SAS-related problem because the SAS interface logic is on the system board. Additionally, appropriate service procedures must be followed when replacing the Cache RAID - Dual IOA Enablement Card since removal of this card can cause data loss if incorrectly performed and can also result in a non-Dual Storage IOA (non-HA) mode of operation.
- Some configurations involve a SAS adapter connecting to internal SAS disk enclosures within a system using a FC3650 or FC3651 cable card. Keep in mind that when the MAP refers to a device enclosure, it could be referring to the internal SAS disk slots or media slots. Also, when the MAP refers to a cable, it could include a FC3650 or FC3651 cable card.
- Some adapters, known as RAID and SSD adapters, contain SSDs, which are integrated on the adapter. See the feature comparison tables for PCIe cards. For these configurations, FRU replacement to solve SAS-related problems is limited to replacing either the adapter or the integrated SSDs because the entire SAS interface logic is contained on the adapter.
- When using SAS adapters in either an HA two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the Primary adapter and not the Secondary adapter.
- Before executing the system verification action in this map, reconstruct any degraded disk arrays if possible. This will help avoid potential data loss resulting from the adapter reset performed during system verification action taken in this map.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, and additional problems might be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array because the disk array might become degraded or might fail, and additional problems might be created if functioning disks are removed from a disk array.

Step 3153-1

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3153-2."

Yes   Go to "Step 3153-6" on page 163.

Step 3153-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: Disregard any trouble found for now, and continue with the next step.

Step 3153-3

Determine whether the problem still exists for the adapter which logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path that is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3153-4" on page 163.

Yes   Go to "Step 3153-6" on page 163.

Step 3153-4

Since the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions has been attempted, then proceed to the next action in the list.

   Note: Prior to replacing parts, consider using a complete power-down of the entire system, including any external device enclosures, to reset all possible failing components. This action might correct the problem without replacing parts.

   - Reseat the cables on the adapter, on the device enclosure, and between cascaded enclosures if present.
   - Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
   - Replace the device.

     Note: If there are multiple devices with a path which is not **Operational**, then the problem is not likely to be with a device.

   - Replace the internal device enclosure or refer to the service documentation for an external expansion drawer to determine what FRU to replace which may contain the SAS expander.
   - Replace the adapter.
   - Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3153-5

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3153-4."

Yes   Go to "Step 3153-6."

Step 3153-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3190

The problem that occurred is uncommon or complex to resolve. Gather information and obtain assistance from your Hardware Service Support organization.

The possible cause for SRN *nnnn* - 9002 is that one or more serial-attached SCSI (SAS) devices were moved from a PCI Express 2.0 (PCIe2) controller to a Peripheral Component Interconnect-X (PCI-X) or PCI Express (PCIe) controller.

Note: If the device was moved from a PCIe2 controller to a PCI-X or PCIe controller, the `Detail Data` section of the hardware error log contains the reason for failure as the Payload CRC Error. For this case, the error can be ignored and the problem is resolved if the devices are moved back to a PCIe2 controller or if the devices are formatted on the PCI-X or PCIe controller.

Step 3190-1

Record the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.
3. Go to "Step 3190-2."

Step 3190-2

Collect any hardware error logged about the same time for the adapter.

Step 3190-3

Collect the current disk array configuration. The disk array configuration can be viewed as follows:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection screen.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration**.
3. Select the IBM SAS RAID Controller identified in the hardware error log.
4. Go to the next step.

Step 3190-4

Contact your hardware service provider.

Exit this procedure.

MAP 3210

Use this MAP to resolve the following problems:
- Incompatible disk is installed at the degraded disk location in the disk array (SRN nnnn-9025) for a PCIe2 controller.
- Disk array is degraded due to a missing or failed disk (SRN *nnnn* - 9030) for a PCIe2 controller.
- Automatic reconstruction was initiated for a disk array (SRN *nnnn* - 9031) for a PCIe2 controller.
- Disk array is degraded due to a missing or failed disk (SRN *nnnn* - 9032) for a PCIe2 controller.

Step 3210-1

Identify the disk array by examining the hardware error log.

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. This error log displays the following disk array information under the heading **Array Information**:**Resource**, **S/N** (serial number), and **RAID Level**.
3. Go to "Step 3210-2."

Step 3210-2

View the current disk array configuration as follows:

1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration**.
3. Select the IBM SAS RAID controller that is identified in the hardware error log.
4. Go to Step "Step 3210-3."

Step 3210-3

Does a disk array have a state of **Degraded**?

No   Go to "Step 3210-4."

Yes   Go to "Step 3210-5" on page 166.

Step 3210-4

The affected disk array has a state of either **Rebuilding** or **Optimal** due to the use of a hot spare disk.

Identify the failed disk, which is no longer a part of the disk array, by finding the pdisk listed at the bottom of the display that has a state of either **Failed** or **RWProtected**. Using appropriate service procedures, such as use of the SCSI and SCSI RAID Hot Plug Manager, remove the failed disk and replace it with a new disk to use as a hot spare. See the "Replacing pdisks" on page 97 section for this procedure, and then continue here.

Return to the List SAS Disk Array Configuration display in the IBM SAS Disk Array Manager. If the new disk is not listed as a pdisk, it might first need to be prepared for use in a disk array. Do the following steps:

1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Create an Array Candidate pdisk and Format to 528 Byte Sectors**.
3. Select the appropriate IBM SAS RAID controller.
4. Select the disks from the list that you want to prepare for use in the disk arrays.

To make the new disk usable as a hot spare, complete the following steps:

1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Change/Show SAS pdisk Status** > **Create a Hot Spare**.
3. Select the IBM SAS RAID controller.

4. Select the pdisk that you want to designate as a hot spare.

Note: Hot spare disks are useful only if their capacity is greater than or equal to that of the smallest capacity disk in a disk array that becomes degraded.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3210-5

Identify the failed disk by finding the pdisk listed for the degraded disk array that has a state of **Failed**. Using appropriate service procedures, such as the SCSI and SCSI RAID Hot Plug Manager, remove the failed disk and replace it with a new disk to use in the disk array. Refer to the "Replacing pdisks" on page 97 section for this procedure, and then continue here.

Note:

If the failed device is on a PCIe SAS RAID and SSD adapter, complete the following steps and then continue here:

1. Use the resource information shown for the failed pdisk and identify the device location on the adapter. For more information, see SAS resource locations.
2. Replace the device as described in Replacing a disk drive with the system or logical partition powered off.

Note: The replacement disk must have a capacity that is greater than or equal to that of the smallest capacity disk in the degraded disk array.

To bring the disk array back to a state of **Optimal**, complete the following steps:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Reconstruct a SAS Disk Array**.
3. Select the failed pdisk to reconstruct.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3211

Use this MAP to resolve the following problems:

- Two or more disks are missing from a RAID 5 or RAID 6 disk array (service request number (SRN) *nnnn*-9020, *nnnn*-9021, or *nnnn*-9022) for a PCIe2 controller.
- One or more disk pairs are missing from a RAID 10 disk array (SRN *nnnn*-9060) for a PCIe2 controller.
- One or more disks are missing from a RAID 0 disk array (SRN *nnnn*-9061 or *nnnn*-9062) for a PCIe2 controller.

Step 3211-1

Identify the disks missing from the disk array by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

> **Note:** The missing disks are those listed under **Array Member Information** with an **Actual Resource** of ***unkwn***.

3. Go to "Step 3211-2."

Step 3211-2

Perform only one of the following options, listed in the order of preference:

Option 1

Locate the identified disks and install them in the correct physical locations (that is, the **Expected Resource**) in the system. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Expected Resource** field.

After installing the disks in the **Expected Resource** locations, complete only one of the following options:

- Run diagnostics in system verification mode on the adapter:
  1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
  2. Select **Run Diagnostics**.
  3. Select the adapter resource.
  4. Select **System Verification**.
- Unconfigure and reconfigure the adapter by performing the following steps:
  1. Unconfigure the adapter.
     a. Start the IBM SAS Disk Array Manager.
        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
     b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
  2. Configure the adapter.
     a. Start the IBM SAS Disk Array Manager.
        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
     b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.
- Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Delete the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.
   a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the remaining members of the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

   a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.

   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3212

Use this MAP to resolve the following problem: One or more disk array members are not at required physical locations (service request number (SRN) *nnnn*-9023) for a PCIe2 controller

Step 3212-1

Identify the disks which are not at their required physical locations by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Select the hardware error log to view.

   The disks that are not at their required locations are those listed under **Array Member Information** field with values **Expected Resource** and **Actual Resource** fields that do not match.

   An **Actual Resource** value of ***unkwn*** is acceptable, and no action is needed to correct it. The value ***unkwn*** for location must only occur for the disk array member that corresponds to the **Degraded Disk S/N** field.

3. Go to "Step 3212-2."

Step 3212-2

Perform only one of the following options, listed in the order of preference:

Option 1

Locate the identified disks and install them in the correct physical locations (that is, the **Expected Resource** field) in the system. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Expected Resource** field.

After installing the disks in the locations shown in the **Expected Resource** field, complete only one of the following options:

- Run diagnostics in system verification mode on the adapter:

  1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

  2. Select **Run Diagnostics**.

  3. Select the adapter resource.

  4. Select **System Verification**.

- Unconfigure and reconfigure the adapter by performing the following steps:

  1. Unconfigure the adapter.

     a. Start the IBM SAS Disk Array Manager.

        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

     b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

  2. Configure the adapter.

     a. Start the IBM SAS Disk Array Manager.

1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

- Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Delete the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.

3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the remaining members of the disk array, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

    a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3213

Use this MAP to resolve the following problem: Disk array is or would become degraded and parity data is out of synchronization (service request number (SRN) nnnn-9027) for a PCI-X or PCIe controller.

Step 3213-1

Identify the adapter and disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. If the disk array member which corresponds to the **Degraded Disk S/N** field has an **Actual Resource** value of ***unkwn*** and is not physically present, viewing the hardware error log can help find this disk.
3. Go to "Step 3213-2."

Step 3213-2

Have the adapter or disks been physically moved recently?

No   Contact your hardware service provider.

Yes   Go to "Step 3213-3" on page 170.

Step 3213-3

Perform only one of the following options, listed in the order of preference:

Option 1

Restore the adapter and disks back to their original configuration. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Expected Resource** and **Actual Resource** fields.

After restoring the adapter and disks to their original configuration, complete only one of the following steps:

- Run diagnostics in system verification mode on the adapter:
    1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    2. Select **Run Diagnostics**.
    3. Select the adapter resource.
    4. Select **System Verification**.
- Unconfigure and reconfigure the adapter by performing the following steps:
    1. Unconfigure the adapter.
        a. Start the IBM SAS Disk Array Manager.
            1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
            2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
        b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
    2. Configure the adapter.
        a. Start the IBM SAS Disk Array Manager.
            1) Start Diagnostics and select **Task Selection** on the Function Selection display.
            2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
        b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.
- Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Delete the disk array, as follows:

Attention: All data on the disk array will be lost.
1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the remaining members of the disk array, as follows:

Attention: All data on the disk array will be lost.
1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3220

Use this MAP to resolve the following problem: Cache data associated with attached disks cannot be found (service request number (SRN) nnnn-9010) for a PCIe2 controller

Note: This problem is not expected to occur for a PCIe2 controller.

Proceed to MAP 3290.

MAP 3221

Use this MAP to resolve the following problem: RAID controller resources not available (SRN *nnnn*-9054) for a PCIe2 controller.

Step 3221-1

Remove any new or replacement disks that have been attached to the adapter, either by using the SCSI and SCSI RAID Hot Plug Manager or by powering off the system.

Perform only one of the following options:

Option 1
> Run diagnostics in system verification mode on the adapter:
> 1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
> 2. Select **Run Diagnostics**.
> 3. Select the adapter resource.
> 4. Select **System Verification**.

Option 2
> Unconfigure and reconfigure the adapter by performing the following steps:
> 1. Unconfigure the adapter.
>   a. Start the IBM SAS Disk Array Manager.
>   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
>   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
> 2. Configure the adapter.
>   a. Start the IBM SAS Disk Array Manager
>   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
>   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
>   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

Option 3
> Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3230

Use this MAP to resolve the following problem: Controller does not support the function expected by one or more disks (SRN *nnnn*-9008) for a PCIe2 controller.

The possible causes are:

- The adapter or disks have been physically moved or changed such that the adapter does not support a function that the disks require.
- The disks were last used under the IBM i operating system.
- The disks were moved from a PCI-X or PCIe controller to a PCIe2 controller, and the disks had one of the following attributes which are not supported by the a PCIe2 controller:
  - The disks were used in a disk array with a stripe-unit size of 16 KB, 64 KB, or 512 KB (that is, a PCIe2 controller supports only a stripe-unit size of 256 KB).
  - The disks were used in a RAID 5 or RAID 6 disk array that had disks added to it after it was initially created (that is, a PCIe2 controller does not support adding disks to a previously created RAID 5 or RAID 6 disk array).

Step 3230-1

Identify the affected disks by examining the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks that are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** fields are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** fields for each of these disks indicate the adapter to which the disk was last attached when it was operational. Refer to "SAS resource locations" on page 107 to understand how to locate a disk using the **Resource** field.

3. Go to "Step 3230-2."

Step 3230-2

Have the adapter or disks been physically moved recently or were the disks previously used by the IBM i operating system?

No   Contact your hardware service provider.

Yes   Go to "Step 3230-3."

Step 3230-3

Perform only one of the following options, listed in the order of preference:

Option 1

   Restore the adapter and disks back to their original configuration. Complete only one of the following steps:

   - Run diagnostics in system verification mode on the adapter:
     1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
     2. Select **Run Diagnostics**.
     3. Select the adapter resource.
     4. Select **System Verification**.
   - Unconfigure and reconfigure the adapter by performing the following steps:
     1. Unconfigure the adapter:

a. Start the IBM SAS Disk Array Manager.

    1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

    2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

2. Configure the adapter:

a. Start the IBM SAS Disk Array Manager.

    1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

    2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

- Perform an IPL of the system or logical partition.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Format the disks, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager.

a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3231

Use this MAP to resolve the following problem: Required cache data cannot be located for one or more disks (SRN *nnnn*-9050) for a PCIe2 controller.

Step 3231-1

Did you just exchange the adapter as the result of a failure?

No   Go to "Step 3231-2."

Yes   Contact your hardware service provider

Step 3231-2

Identify the affected disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Select the hardware error log to view.

Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks that are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** fields are provided for up to three disks. Additionally, the **Original Controller**

Type, S/N, and World Wide ID fields for each of these disks indicate the adapter to which the disk was last attached when it was operational. See "SAS resource locations" on page 107 to understand how to locate a disk using the Resource field.

3. Go to "Step 3231-3."

Step 3231-3

Have the adapter or disks been physically moved recently?

No   Contact your hardware service provider

Yes   Go to "Step 3231-4"

Step 3231-4

Is the data on the disks needed for this or any other system?

No   Go to "Step 3231-6"

Yes   Go to "Step 3231-5"

Step 3231-5

The adapter and disks, identified previously, must be reunited so that the cache data can be written to the disks.

Restore the adapter and disks back to their original configuration. After the cache data is written to the disks and the system is powered off normally, you can move the adapter or disks, or both to another location.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3231-6

Option 1

Reclaim controller cache storage by performing the following steps:

Attention: All data on the disk array will be lost.
1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage.** > **IBM SAS RAID Controller**.
3. Confirm that you will allow unknown data loss.
4. Confirm that you want to proceed.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

If the disks are members of a disk array, delete the disk array by doing the following steps:

Attention: All data on the disk array will be lost.
1. Start the IBM SAS Disk Array Manager as follows:
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.

3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Format the disks, as follows:

Attention: All data on the disk array will be lost.

1. Start the IBM SAS Disk Array Manager as follows:

    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.

    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3232

Use this MAP to resolve the following problem: Cache data exists for one or more missing or failed disks (SRN *nnnn*-9051) for a PCIe2 controller.

The possible causes follow:

- One or more disks have failed on the adapter.
- One or more disks were either moved concurrently or were removed after an abnormal power off.
- The adapter was moved from a different system or a different location on this system after an abnormal power off.
- The cache of the adapter was not cleared before it was shipped to the customer.

Step 3232-1

Identify the affected disks by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Select the hardware error log to view. Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks which are affected. The **Device Errors Logged** field indicates the number of disks for that detailed information is provided. Under the **Original Device** heading, the **Vendor/Product ID**, **S/N**, and **World Wide ID** fields are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** fields for each of these disks indicate the adapter to which the disk was last attached when it was operational. See "SAS resource locations" on page 107 to understand how to locate a disk by using the Resources field.

3. Go to "Step 3232-2."

Step 3232-2

Are there other disk or adapter errors that have occurred at approximately the same time as this error?

No Go to "Step 3232-3."

Yes Go to "Step 3232-6" on page 176.

Step 3232-3

Is the data on the disks (and thus the cache data for the disks) needed for this or any other system?

No   Go to "Step 3232-7."

Yes   Go to "Step 3232-4."

Step 3232-4

Have the adapter card or disks been physically moved recently?

No   Contact your hardware service provider.

Yes   Go to "Step 3232-5."

Step 3232-5

The adapter and disks must be reunited so that the cache data can be written to the disks.

Restore the adapter and disks back to their original configuration.

After the cache data is written to the disks and the system is powered off normally, the adapter or disks can be moved to another location.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3232-6

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3232-7

Reclaim the Controller Cache Storage by performing the following steps:

Attention: Data will be lost.
1. Start the IBM SAS Disk Array Manager.
   a. Start AIX Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Reclaim Controller Cache Storage** > **IBM SAS RAID Controller**.
3. Confirm that you will allow unknown data loss.
4. Confirm that you wish to proceed.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3233

Use this MAP to resolve the following problems:
- Disk has been changed after the last known status (SRN *nnnn*-9090) for a PCIe2 controller.
- The disk configuration was incorrectly changed (SRN *nnnn*-9091) for a PCIe2 controller.

Step 3233-1

Perform only one of the following options:

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Option 1

Run diagnostics in system verification mode on the adapter:

1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Option 2

Unconfigure and reconfigure the adapter by performing the following steps:

1. Unconfigure the adapter.
   a. Start the IBM SAS Disk Array Manager.
      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.
2. Configure the adapter.
   a. Start the IBM SAS Disk Array Manager.
      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.
      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

Option 3

Perform an IPL of the system or logical partition:

Step 3233-2

Take action on any other errors that are now occurring.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3234

Use this MAP to resolve the following problem: Disk requires a format before use (SRN nnnn-9092) for a PCIe2 controller.

The possible causes are:

- The disk is a previously failed disk from a disk array and was automatically replaced by a hot spare disk.
- The disk is a previously failed disk from a disk array and was removed and later reinstalled on a different adapter or at a different location on this adapter.
- Appropriate service procedures were not followed when disks were replaced or when the adapter was reconfigured, such as not using the SCSI and SCSI RAID Hot Plug Manager when concurrently removing or installing disks, or not performing a normal power off of the system prior to reconfiguring disks and adapters.
- The disk is a member of a disk array, but was detected subsequent to the adapter being configured.
- The disk has multiple or complex configuration problems.

Step 3234-1

Identify the affected disks by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.

   Viewing the hardware error log, the **Device Errors Detected** field indicates the total number of disks that are affected. The **Device Errors Logged** field indicates the number of disks for which detailed information is provided. Under the **Original Device** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** are provided for up to three disks. Additionally, the **Original Controller Type**, **S/N**, and **World Wide ID** for each of these disks indicates the adapter to which the disk was last attached when it was operational. Refer to "SAS resource locations" on page 107 to understand how to locate a disk using the **Resource** field.
3. Go to "Step 3234-2."

Step 3234-2

Did other disk or adapter errors occur at about the same time as this error?

No   Go to "Step 3234-3."

Yes   Go to "Step 3234-5."

Step 3234-3

Have the adapter or disks been physically moved recently?

No   Go to "Step 3234-4."

Yes   Go to "Step 3234-6."

Step 3234-4

Is the data on the disks needed for this or any other system?

No   Go to "Step 3234-7" on page 180.

Yes   Go to "Step 3234-6."

Step 3234-5

Take action on the other errors that occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3234-6

Perform only one of the following options that is most applicable to your situation:

Option 1

Perform only one of the following to cause the adapter to rediscover the disks and then take action on any new errors:
- Run diagnostics in system verification mode on the adapter
  1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
  2. Select **Run Diagnostics**.
  3. Select the adapter resource.
  4. Select **System Verification**.
- Unconfigure and reconfigure the adapter by performing the following steps:
  1. Unconfigure the adapter.

a. Start the IBM SAS Disk Array Manager.

   1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

   2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

2. Configure the adapter.

   a. Start the IBM SAS Disk Array Manager.

      1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

      2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

   b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

- Perform an IPL on the system or logical partition

Take action on any other errors that are now occurring.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Restore the adapter and disks to their original configuration. After this has been done, complete only one of the following options:

- Run diagnostics in system verification mode on the adapter:
  1. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
  2. Select **Run Diagnostics**.
  3. Select the adapter resource.
  4. Select **System Verification**.
- Unconfigure and reconfigure the adapter by performing the following steps:
  1. Unconfigure the adapter.
     a. Start the IBM SAS Disk Array Manager.

        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

     b. Select **Diagnostics and Recovery Options** > **Unconfigure an Available IBM SAS RAID Controller**.

  2. Configure the adapter.
     a. Start the IBM SAS Disk Array Manager.

        1) Start AIX diagnostics and select **Task Selection** on the Function Selection display.

        2) Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

     b. Select **Diagnostics and Recovery Options** > **Configure a Defined IBM SAS RAID Controller**.

- Perform an IPL of the system or logical partition

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 3

Remove the disks from this adapter.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3234-7

Perform only one of the following options.

Option 1

If the disks are members of a disk array, delete the disk array by doing the following steps:

Attention: All data on the disk array will be lost.

Note: In some rare scenarios, deleting the disk array will not have any effect on a disk and the disk must be formatted instead.

1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Delete a SAS Disk Array** > **IBM SAS RAID Controller**.
3. Select the disk array to delete.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Option 2

Do the following to format the disks:

Attention: All data on the disks will be lost.

1. Start the IBM SAS Disk Array Manager.
    a. Start AIX diagnostics and select **Task Selection** on the Function Selection display.
    b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options.** > **Format Physical Disk Media (pdisk).**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3235

Use this MAP to resolve the following problem: Disk media format bad (SRN nnnn-FFF3) for a PCI-X or PCIe controller

The possible causes are:
- The disk was being formatted and was powered off during this process.
- The disk was being formatted and was reset during this process.

Step 3235-1

Identify the affected disk by examining the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. In the hardware error log, under the **Disk Information** heading, the **Resource**, **Vendor/Product ID**, **S/N**, and **World Wide ID** fields are provided for the disk. See "SAS resource locations" on page 107 to understand how to locate a disk by using the **Resource** field.
3. Go to "Step 3235-2."

Step 3235-2

Format the disk by doing the following steps:

Attention: All data on the disks will be lost.

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Format Physical Disk Media (pdisk)**.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3240

Use this MAP to resolve the following problem: Multiple controllers connected in an invalid configuration (SRN *nnnn*-9073) for a PCIe2 controller

The possible causes are:
- Incompatible adapters are connected to each other. Such an incompatibility includes invalid adapter combinations such as the following situations. See the feature comparison tables for PCIe2 cards for a list of the supported adapters and their attributes.
  - A PCI-X or PCIe controller is connected to a PCIe2 controller.
  - Adapters have different write cache sizes.
  - One adapter is not supported by AIX.
  - An adapter that supports multi-initiator and high availability is connected to another adapter that does not have the same support.
  - More than two adapters are connected for multi-initiator and high availability.
  - Adapter microcode levels are not up to date or are not at the same level of functionality.
- One adapter, of a connected pair of adapters, is not operating under the AIX operating system. Connected adapters must both be controlled by AIX.
- Adapters connected for multi-initiator and high availability are not cabled correctly. Each type of high availability configuration requires specific cables be used in a supported manner.

Step 3240-1

Determine which of the possible causes applies to the current configuration and take the appropriate actions to correct it. If this does not correct the error, contact your hardware service provider.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3241

Use this MAP to resolve the following problem: Multiple controllers are not capable of similar functions or of controlling the same set of devices (SRN nnnn-9074) for a PCIe2 controller.

Step 3241-1

This error relates to adapters connected in a multi-initiator and high availability configuration. To obtain the reason or description for this failure, you must find the formatted error information in the AIX error log. This also contains information about the attached adapter in the **Remote Adapter** field.

Display the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. In the hardware error log, the **Detail Data** section contains the reason for failure and the values for **Remote Adapter Vendor ID**, **Product ID**, **Serial Number**, and **World Wide ID** fields.

3. Go to "Step 3241-2."

Step 3241-2

Find the reason for failure and information for the attached adapter (remote adapter) that is shown in the error log, and perform the action listed for the reason in the following table:

Table 17. RAID array reason for failure

Reason for failure	Description	Action	Adapter on which to perform the action
The secondary adapter does not support RAID level being used by the primary adapter.	The secondary adapter detected that the primary has a RAID array with a RAID level that the secondary adapter does not support.	The customer needs to upgrade the type of the secondary adapter or change the RAID level of the array on the primary to a level that is supported by the secondary adapter. Physically change the type of adapter that logged the error.	Remote adapter indicated in the error log.
The secondary adapter does not support disk function being used by the primary adapter.	The secondary adapter detected a device function that it does not support.	The customer might need to upgrade the adapter microcode or upgrade the type of the secondary adapter.	Adapter that logged the error.
The secondary adapter is unable to find devices found by the primary adapter.	The secondary adapter cannot discover all the devices that the primary adapter has.	Verify the connections to the devices from the adapter logging the error. View the disk array configuration display to determine the SAS port with the problem.	Adapter that logged the error.
The secondary adapter found devices not found by the primary adapter.	The secondary adapter has discovered more devices than the primary. After this error is logged, an automatic failover will occur.	Verify the connections to the devices from the remote adapter as indicated in the error log. View the disk array configuration display to determine the SAS port with the problem.	Remote adapter indicated in the error log.
The secondary port not connected to the same numbered port on primary adapter.	SAS connections from the adapter to the devices are incorrect. Common disk expansion drawers must be attached to the same numbered SAS port on both adapters.	Verify the connections and recable SAS connections as necessary.	Either adapter.
The primary adapter lost contact with disks accessible by the secondary adapter.	The primary adapter is unable to link to the devices. An automatic failover will occur.	Verify the cable connections from the adapter that logged the error. Possible disk expansion drawer failure.	Adapter that logged the error.
Other		Contact your hardware service provider.	

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3242

Use this MAP to resolve the following problem:

Configuration error: incorrect connection between cascaded enclosures (SRN *nnnn*-4010) for a PCIe2 controller.

The possible causes follow:
- Incorrect cabling of cascaded device enclosures
- Use of an unsupported device enclosure

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3242-1

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. View the hardware error log as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the **Resource** field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001


0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98          ^

         |

     Resource is 0004FFFF
```

Using the resource found in step 2, see "SAS resource locations" on page 107 to understand how to identify the controller's port to which the device, or device enclosure, is attached.

For example, if the resource is 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3242-2

Review the device enclosure cabling and correct the cabling as required. To see examples of device configurations with SAS cabling, see Serial attached SCSI cable planning.

If unsupported device enclosures are attached, then either remove or replace them with supported device enclosures.

Step 3242-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error recur?

No   Go to "Step 3242-4."

Yes   Contact your hardware service provider.

Step 3242-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3243

Use this MAP to resolve the following problem:

Configuration error: connections exceed controller design limits (SRN *nnnn*-4020) for a PCIe2 controller.

The possible causes follow:
- Unsupported number of cascaded device enclosures
- Improper cabling of cascaded device enclosures

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3243-1

Identify the adapter SAS port associated with the problem by examining the hardware error log. The hardware error log might be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the **Resource** field from the `Detail Data / PROBLEM DATA` section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001



0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98          ^

        |

      Resource is 0004FFFF
```

Using the resource found in step 2, see "SAS resource locations" on page 107 to understand how to identify the controller's port to which the device, or device enclosure, is attached.

For example, if the resource is 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3243-2

Reduce the number of cascaded device enclosures. Device enclosures might only be cascaded one level deep, and only in certain configurations.

Review the device enclosure cabling and correct the cabling as required. To see examples of device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3243-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error recur?

No   Go to "Step 3243-4."

Yes   Contact your hardware service provider.

Step 3243-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3244

Use this MAP to resolve the following problems:

- Configuration error: incorrect multipath connection (SRN *nnnn*-4030) for a PCIe2 controller.
- Configuration error: incomplete multipath connection between the controller and the enclosure detected (SRN nnnn-4040) for a PCIe2 controller.

The possible causes follow:

- Incorrect cabling to device enclosure.

  Note: Pay special attention to the requirement that a Y0 cable, YI cable, or Xcable must be routed along the right side of the rack frame, as viewed from the rear, when connecting to a disk expansion drawer. Review the device enclosure cabling and correct the cabling as required.

- A failed connection caused by a failing component in the SAS fabric between, and including, the controller and device enclosure.

Considerations:

- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.

- When using SAS adapters in either a high availability (HA) two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the primary adapter and not the secondary adapter.
- Before doing the system verification action in this map, reconstruct any degraded disk arrays if possible. This action helps avoid potential data loss that might result from the adapter being reset during the system verification action taken in this map.

Attention: Obtain assistance from your hardware service support organization before you replace RAID adapters when SAS fabric problems exist. Because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, additional problems might be created by replacing an adapter when SAS fabric problems exist. Appropriate service procedures must be followed when you replace the Cache RAID - Dual IOA Enablement Card (for example, FC5662) because removal of this card can cause data loss if incorrectly performed, and can also result in a nondual Storage IOA (non-HA) mode of operation.

Step 3244-1

Was the SRN *nnnn*-4030?

No   Go to "Step 3244-5" on page 187.

Yes   Go to "Step 3244-2."

Step 3244-2

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the **Resource** field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001



0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98          ^
          |
      Resource is 0004FFFF
```

Using the resource found in the step 2, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the resource is equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3244-3

Review the device enclosure cabling and correct the cabling as required. To see examples of device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3244-4

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error recur?

No Go to "Step 3244-10" on page 189.

Yes Contact your hardware service provider.

Step 3244-5

The SRN is *nnnn*-4040.

Determine if a problem still exists for the adapter that logged this error by examining the SAS connections as follows:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options**.
3. Select **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as `Operational`?

No Go to "Step 3244-6."

Yes Go to "Step 3244-10" on page 189.

Step 3244-6

Run diagnostics in System Verification mode on the adapter to rediscover the devices and connection:.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: At this point, ignore any problems found and continue with the next step.

Step 3244-7

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

3. Select a device with a path that is not marked **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No　Go to "Step 3244-8."

Yes　Go to "Step 3244-10" on page 189.

Step 3244-8

After the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions was previously attempted, proceed to the next action in the list.

   Note: Prior to replacing parts, consider using a complete shutdown and power-off of the entire system, including any external device enclosures, to reset all possible failing components. This action might correct the problem without replacing parts.
   * Reseat cables on the adapter and the device enclosure.
   * Replace the cable from the adapter to the device enclosure.
   * Replace the internal device enclosure or see the service documentation for the external expansion drawer to determine which field replaceable unit (FRU) to replace that might contain the SAS expander.
   * Replace the adapter.
   * Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3244-9

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path that is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No　Go to "Step 3244-8."

Yes　Go to "Step 3244-10" on page 189.

Step 3244-10

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3245

Use this MAP to resolve the following problem: Unsupported enclosure function detected (SRN nnnn-4110) for a PCIe2 controller

The possible causes follow:
- Device enclosure or adapter microcode levels are not up to date.
- The type of device enclosure or device is not supported.

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3245-1

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. The hardware error log can be viewed as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the Resource field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001



0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98                    ^

        |

     Resource is 0004FFFF
```

Using the resource found in step 2, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the resource is equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3245-2

Ensure that the device enclosure or adapter microcode levels are up to date.

If unsupported device enclosures or devices are attached, either remove or replace them with supported device enclosures or devices.

Review the device enclosure cabling, and correct the cabling as required. To see examples of device configurations with SAS cabling, see Serial attached SCSI cable planning.

Step 3245-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error reoccur?

No   Go to "Step 3245-4."

Yes   Contact your hardware service provider.

Step 3245-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3246

Use this MAP to resolve the following problem:

Configuration error: incomplete multipath connection between enclosures and the device were detected (SRN *nnnn* - 4041) for a PCIe2 controller.

A possible cause is the failed connection that was caused by a failing component within the device enclosure, including the device itself.

Note: The adapter is not a likely cause of this problem.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- When using SAS adapters in either a high availability (HA) two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the primary adapter and not the secondary adapter.
- Before doing the system verification action in this map, reconstruct any degraded disk arrays if possible. This action helps avoid potential data loss that could result from the adapter being reset during the system verification action taken in this map.

Attention: Removing functioning disks in a disk array is not recommended without assistance from your hardware service support organization. A disk array might become degraded or failed if functioning disks are removed and additional problems might be created.

Step 3246-1

Determine wheter a problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as `Operational`?

No   Go to "Step 3246-2."

Yes   Go to "Step 3246-6" on page 192.

Step 3246-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: At this point, disregard any problems found, and continue with the next step.

Step 3246-3

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path that is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3246-4."

Yes   Go to "Step 3246-6" on page 192.

Step 3246-4

Because the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions was previously attempted, then proceed to the next action in the list.

   Note: Prior to replacing parts, consider using a complete shutdown to power off the entire system, including any external device enclosures, to reset possible failing components. This might correct the problem without replacing parts.

   • Review the device enclosure cabling and correct the cabling as required. To see example device configurations with SAS cabling, see Serial-attached SCSI cable planning.
   • Reseat cables on the adapter, on the device enclosure, and between cascaded enclosures if present.

- Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
- Replace the internal device enclosure or see the service documentation for an external expansion drawer to determine which field replaceable unit (FRU) to replace that might contain the SAS expander.
- Replace the device.
- Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3246-5

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3246-4" on page 191.

Yes   Go to "Step 3246-6."

Step 3246-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3247

Use this MAP to resolve the following problem: Missing remote controller (SRN nnnn-9076) for a PCIe2 controller

Step 3247-1

An adapter attached in either an auxiliary cache or multi initiator and high availability configuration was not discovered in the allotted time. To obtain additional information about the configuration involved, locate the formatted error information in the AIX error log.

Display the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Go to "Step 3247-2" on page 193.

Step 3247-2

Determine which of the following items is the cause of your specific error, and take the appropriate actions listed. If this does not correct the error, contact your hardware service provider.

The possible causes follow:

- An attached adapter for the configuration is not installed or is not powered on. Some adapters are required to be part of an high availability (HA) RAID configuration. Verify this requirement in the feature comparison tables for PCIe2 cards. Ensure that both adapters are correctly installed and powered on.
- If this is an auxiliary cache or HA single-system RAID configuration, both adapters might not be in the same partition. Ensure that both adapters are assigned to the same partition.
- An attached adapter does not support the desired configuration. Verify whether such a configuration support exists by reviewing the feature comparison tables for PCIe2 cards to see whether the entries for the auxiliary write cache (AWC) support, HA two-system RAID, HA two-system JBOD, or HA single-system RAID support have Yes in the column for the desired configuration.
- An attached adapter for the configuration failed. Take action on the other errors that have occurred at the same time as this error.
- Adapter microcode levels are not up to date or are not at the same level of functionality. Ensure that the microcode for both adapters is at the latest level.

Note: The adapter that is logging this error runs in a performance degraded mode, without caching, until the problem is resolved.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3248

Use this MAP to resolve the following problem: Attached enclosure does not support the required multipath function (SRN *nnnn*-4050) for a PCIe2 controller.

The possible cause is the use of an unsupported device enclosure.

Consider removing power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.

Step 3248-1

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Obtain the **Resource** field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001


0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98          ^
```

```
        |

   Resource is 0004FFFF
```

Using the resource found, see "SAS resource locations" on page 107 to understand how to identify the controller's port that the device, or device enclosure, is attached.

For example, if the resource is equal to 0004FFFF, port 04 on the adapter is used to attach the device or device enclosure that is experiencing the problem.

Step 3248-2

If unsupported device enclosures are attached, either remove or replace them with supported device enclosures.

Step 3248-3

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.
1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Referring to the steps in "Examining the hardware error log" on page 118, did the error recur?

No   Go to "Step 3248-4."

Yes   Contact your hardware service provider.

Step 3248-4

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3249

Use this MAP to resolve the following problem: Incomplete multipath connection between the controller and the remote controller (SRN *nnnn*-9075) for a PCIe2 controller.

Note:
This problem is not expected to occur for a PCIe2 controller.

Proceed to "MAP 3290" on page 204.

.

MAP 3250

Use this MAP to perform SAS fabric problem isolation for a PCIe2 controller.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have the disk enclosure or the removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter; because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, and additional problems might be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array; because the disk array might become degraded or might fail, and additional problems might be created if functioning disks are removed from a disk array.

Attention: Removing functioning disks in a disk array is not recommended without assistance from your hardware service support organization. A disk array might become degraded or might fail if functioning disks are removed, and additional problems might be created.

Step 3250-1

Was the SRN *nnnn*-3020?

No   Go to "Step 3250-3."

Yes   Go to "Step 3250-2."

Step 3250-2

The possible causes follow:

- More devices are connected to the adapter than the adapter supports. Change the configuration to reduce the number of devices below what is supported by the adapter.
- A SAS device has been incorrectly moved from one location to another. Either return the device to its original location or move the device while the adapter is powered off or unconfigured.
- A SAS device has been incorrectly replaced by a SATA device. A SAS device must be used to replace a SAS device.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3250-3

Determine whether any of the disk arrays on the adapter are in a **Degraded** state as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager**.
   c. Select **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration**.
3. Select the IBM SAS RAID controller that was identified in the hardware error log.

Does any disk array have a state of **Degraded**?

No   Go to "Step 3250-5" on page 196.

Yes   Go to "Step 3250-4."

Step 3250-4

Other errors should have occurred related to the disk array being in a **Degraded** state. Take action on these errors to replace the failed disk and to restore the disk array to an **Optimal** state.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3250-5

Have other errors occurred at the same time as this error?

No   Go to "Step 3250-7."

Yes   Go to "Step 3250-6."

Step 3250-6

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3250-7

Was the SRN *nnnn*-FFFE?

No   Go to "Step 3250-10."

Yes   Go to "Step 3250-8."

Step 3250-8

Ensure that the device, the device enclosure, and the adapter microcode levels are up to date.

Did you update to newer microcode levels?

No   Go to "Step 3250-10."

Yes   Go to "Step 3250-9."

Step 3250-9

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Step 3250-10

Identify the adapter SAS port that is associated with the problem by examining the hardware error log. The hardware error log can be viewed as follows:

1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view. In the hardware error log, under the **Disk Information** heading, the **Resource** field can be used to identify which controller port the error is associated with.

Note: If you do not see the **Disk Information** heading in the error log, obtain the **Resource** field from the **Detail Data / PROBLEM DATA** section as illustrated in the following example:

```
Detail Data

PROBLEM DATA

0001 0800 1910 00F0 0408 0100 0101 0000 0150 003E 0000 0030 57B5 4100 0000 0001


0004 FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0004 AA98

           ^

           |

       Resource is 0004FFFF
```

Go to "Step 3250-11."

Step 3250-11

Using the resource found in step 2, see "SAS resource locations" on page 107 to understand how to
identify the controller's port to which the device, or device enclosure, is attached.

For example, if the resource is equal to 0004FFFF, port 04 on the adapter is used to attach the device, or
the device enclosure that is experiencing the problem.

The resource found in the previous step can also be used to identify the device. To identify the device,
you can attempt to match the resource with one found on the display, which is displayed by completing
the following steps:

1. Start the IBM SAS Disk Array Manager:

   a. Start the diagnostics program and select **Task Selection** from the Function Selection display.

   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.

2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show
   Physical Resource Locations**.

Step 3250-12

Because the problem persists, some corrective action is needed to resolve the problem. Using the port or
device information found in the previous step, proceed by doing the following steps:

1. Power off the system or logical partition.

2. Perform only one of the following corrective actions, which are listed in the order of preference. If one
   of the corrective actions was previously attempted, proceed to the next action in the list.

   Note: Prior to replacing parts, consider using a complete power-down of the entire system, including
   any external device enclosures, to reset all possible failing components. This might correct the
   problem without replacing parts.

   - Reseat the cables on the adapter and the device enclosure.

   - Replace the cable from the adapter to the device enclosure.

   - Replace the device.

     Note: If multiple devices have a path that is not marked as **Operational**, the problem is not likely
     to be with a device.

   - Replace the internal device enclosure, or see the service documentation for an external expansion
     drawer.

   - Replace the adapter.

- Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3250-13

Does the problem still occur after performing the corrective action?

No   Go to "Step 3250-14."

Yes   Go to "Step 3250-12" on page 197.

Step 3250-14

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3252

Use this MAP to resolve the following problems:
- A device bus fabric error (SRN nnnn-4100) for a PCIe2 controller.
- A temporary device bus fabric error (SRN nnnn-4101) for a PCIe2 controller.

The possible causes follow:
- A failed connection caused by a failing component in the SAS fabric between, and including, the adapter and the device enclosure.
- A failed connection caused by a failing component within the device enclosure, including the device itself.

Considerations:
- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have the disk enclosure or the removable media enclosure integrated in the system with no cables. For these configurations, the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- When using SAS adapters in either a high availability (HA) two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the primary adapter (not the secondary adapter).
- Before doing the system verification action in this map, reconstruct any degraded disk arrays if possible. This action helps to avoid potential data loss that might result from the adapter being reset during system verification action taken in this map.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, additional problems might be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array because the disk array might become degraded or might fail, and additional problems might be created if functioning disks are removed from a disk array.

Step 3252-1

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3252-2."

Yes   Go to "Step 3252-6" on page 200.

Step 3252-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: Disregard any trouble found for now, and continue with the next step.

Step 3252-3

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3252-4" on page 200.

Yes   Go to "Step 3252-6" on page 200.

Step 3252-4

Because the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions was previously attempted, proceed to the next action in the list.

   Note: Prior to replacing parts, consider powering off of the entire system, including any external device enclosures, to reset all possible failing components. This action might correct the problem without replacing parts.

   - Reseat the cables on the adapter, on the device enclosure, and between cascaded enclosures if present.
   - Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
   - Replace the device.

      Note: If multiple devices have a path that is not marked as **Operational**, the problem is not likely to be with a device.

   - Replace the internal device enclosure, or see the service documentation for an external expansion drawer.
   - Replace the adapter.
   - Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3252-5

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3252-4."

Yes   "Step 3252-6."

Step 3252-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3253

Use this MAP to resolve the following problem: Multipath redundancy level got worse (SRN *nnnn* - 4060) for a PCIe2 controller.

The possible causes follow:

- A failed connection caused by a failing component in the SAS fabric between, and including, the adapter and device enclosure.
- A failed connection caused by a failing component within the device enclosure, including the device itself.
- A failed connection caused by a failing component between two SAS adapters, including the AA-cable or the SAS adapters themselves.

   Note: To view all the paths between two SAS adapters, it might be necessary to use the **Show Fabric Path Data** view instead of the **Show Fabric Path Graphical** view.

Considerations:

- Remove power from the system before connecting and disconnecting cables or devices, as appropriate, to prevent hardware damage or erroneous diagnostic results.
- Some systems have the disk enclosure or removable media enclosure integrated in the system with no cables. For these configurations the SAS connections are integrated onto the system boards and a failed connection can be the result of a failed system board or integrated device enclosure.
- When using SAS adapters in either a high availability (HA) two-system RAID or HA single-system RAID configuration, ensure that the actions taken in this MAP are against the primary adapter and not the secondary adapter.
- Before dong the system verification action in this map, reconstruct any degraded disk arrays if possible. This action helps to avoid the potential data loss that might result from the adapter being reset during system verification action taken in this map.

Attention: When SAS fabric problems exist, obtain assistance from your hardware service provider before performing any of the following actions:

- Obtain assistance before you replace a RAID adapter because the adapter might contain nonvolatile write cache data and configuration data for the attached disk arrays, additional problems might be created by replacing an adapter.
- Obtain assistance before you remove functioning disks in a disk array because the disk array might become degraded or might fail, and additional problems might be created if functioning disks are removed from a disk array.

Step 3253-1

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3253-2" on page 202.

Yes   Go to "Step 3253-6" on page 203.

Step 3253-2

Run diagnostics in system verification mode on the adapter to rediscover the devices and connections.

1. Start Diagnostics and select **Task Selection** on the Function Selection display.
2. Select **Run Diagnostics**.
3. Select the adapter resource.
4. Select **System Verification**.

Note: Disregard any trouble found for now, and continue with the next step.

Step 3253-3

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources**
3. Select **Show Fabric Path Graphical View**.
4. Select a device with a path that is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3253-4."

Yes   Go to "Step 3253-6" on page 203.

Step 3253-4

Because the problem persists, some corrective action is needed to resolve the problem. Proceed by doing the following steps:

1. Power off the system or logical partition.
2. Perform only one of the following corrective actions, which are listed in the order of preference. If one of the corrective actions was previously attempted, then proceed to the next one in the list.

   Note: Prior to replacing parts, consider using a complete powered-down of the entire system, including any external device enclosures, to provide a reset of all possible failing components. This action might correct the problem without replacing parts.

   • Reseat the cables on the adapter, on the device enclosure, and between cascaded enclosures if present.
   • Replace the cable from the adapter to the device enclosure, and between cascaded enclosures if present.
   • Replace the device.

     Note: If multiple devices have a path which is not marked as **Operational**, the problem is not likely to be with a device.

   • Replace the internal device enclosure, or see the service documentation for an external expansion drawer.
   • Replace the adapter.

- Contact your hardware service provider.
3. Power on the system or logical partition.

   Note: In some situations, it might be acceptable to unconfigure and reconfigure the adapter instead of powering off and powering on the system or logical partition.

Step 3253-5

Determine whether the problem still exists for the adapter that logged this error by examining the SAS connections as follows:

1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **Diagnostics and Recovery Options** > **Show SAS Controller Physical Resources** > **Show Fabric Path Graphical View**.
3. Select a device with a path which is not marked as **Operational**, if one exists, to obtain additional details about the full path from the adapter port to the device. See "Viewing SAS fabric path information" on page 100 for an example of how this additional detail can be used to help isolate where in the path the problem exists.

Do all expected devices appear in the list and are all paths marked as **Operational**?

No   Go to "Step 3253-4" on page 202.

Yes   Go to "Step 3253-6."

Step 3253-6

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

MAP 3254

Use this MAP to resolve the following problem: Device bus fabric performance degradation (SRN nnnn-4102) for a PCIe2 controller.

Note: This problem is not common for a PCIe2 controller.

Proceed to "MAP 3290" on page 204.

.

MAP 3260

Use this MAP to resolve the following problem:
- Controller T10 device input format (DIF) host bus error (SRN *nnnn*-4170) for a PCIe2 controller.
- Controller recovered T10 DIF host bus error (SRN *nnnn*-4171) for a PCIe2 controller.

Note: This problem is not common for a PCIe2 controller.

Proceed to "MAP 3290" on page 204.

MAP 3261

Use this MAP to resolve the following problem:
- Configuration error: cable VPD cannot be read (SRN *nnnn*-4120) for a PCIe2 controller.

- Configuration error: required cable is missing (SRN *nnnn*-4121) for a PCIe2 controller.
- Configuration error: invalid cable vital product data (SRN *nnnn*-4123) for a PCIe2 controller.

Note: This problem is not common for a PCIe2 controller.

Proceed to "MAP 3290."

MAP 3290

The problem that occurred is uncommon or complex to resolve. Gather information and obtain assistance from your hardware service support organization.

Step 3290-1

Record the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.
2. Select the hardware error log to view.
3. Go to "Step 3290-2."

Step 3290-2

Collect any hardware errors that were logged about the same time for the adapter.

Step 3290-3

Collect the current disk array configuration. The disk array configuration can be viewed as follows:
1. Start the IBM SAS Disk Array Manager.
   a. Start Diagnostics and select **Task Selection** on the Function Selection display.
   b. Select **RAID Array Manager** > **IBM SAS Disk Array Manager**.
2. Select **List SAS Disk Array Configuration** > **IBM SAS RAID Controller**.

Step 3290-4

Contact your hardware service provider.

.

MAP 3295

Use this MAP to resolve the following problem:

Thermal error: controller exceeded maximum operating temperature (SRN *nnnn*-4080) or a PCIe2 controller.

Step 3295-1

The storage controller chip exceeded the maximum normal operating temperature. The adapter continues to run unless the temperature rises to the point where errors or a hardware failure occurs. The adapter is not likely to be the cause of the overtemperature condition.

Display the hardware error log. View the hardware error log as follows:
1. Follow the steps in "Examining the hardware error log" on page 118 and return here.

2. Select the hardware error log to view. In the hardware error log, the **Detail Data** section contains the current temperaturs (in degrees Celsius in hexadecimal notation) and maximum operating temperature (in degrees Celsius in hexadecimal notation) at the time the error was logged.

3. Go to "Step 3295-2" to determine the possible cause and necessary action to prevent exceeding the maximum operating temperature.

Step 3295-2

Determine which of the following items is the cause of exceeding the maximum operating temperature and take the appropriate actions listed. If this action does not correct the error, contact your hardware service provider.

The possible causes follow:

- The adapter is installed in an unsupported system. Verify the adapter is supported on this system by checking in the PCI adapter information by feature type.
- The adapter is installed in an unsupported slot location within the system unit or I/O enclosure. Verify the adapter is located in a supported slot location. See PCI Adapter placement information for the machine type model (MTM) where the adapter is located.
- The adapter is installed in a supported system, but the system is not operating in the required airflow mode; for example, the adapter is in an 8202-E4B or 8205-E6B system that is running in *acoustic mode*. Verify any system specific requirements for this adapter by checking the PCI adapter information by feature type.
- Ensure that no issues affect proper cooling, that is, no fan failures or obstructions.

Note: The adapter that is logging this error continues to log this error while the adapter remains above the maximum operating temperature or each time it exceeds the maximum operating temperature.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and do the "Verifying the repair" procedure.

Finding a service request number from an existing AIX error log

Typically, error log analysis examines the error logs and presents a service request number (SRN) to the user as appropriate, but you can also determine an SRN from an existing AIX error log.

1. Display the error log using the AIX **errpt** command (for example errpt for a summary followed by `errpt –a –s timestamp or errpt –a –N resource_name`).

2. For a PCI-X or PCIe controller, ensure that the Error ID is of the form SISSAS_xxxx (for example SISSAS_ARY_DEGRADED). For a PCIe2 controller ensure that the Error ID is of the form VRSAS_xxxx (for example VRSAS_ARY_DEGRADED). Only Error IDs of the form SISSAS_xxxx or VRSAS_xxxx are potentially related to disk arrays.

3. Locate the **SENSE DATA** in the **Detail Data**.

4. For a PCI-X or PCIe controller, identify the CCIN in bytes 40-43 of the **SENSE DATA** from the 64 bytes shown. For a PCIe2 controller, identify the CCIN in bytes 24-27 of the SENSE DATA from the 96 bytes shown. Use the Sample AIX error log to help you identify the CCIN. The first 4 digits of the SRN, known as the failing function code (FFC), can be found in the following table:

CCIN of SENSE DATA	Failing function code (FFC)
572A	2515
572B	2516
572C	2502
572F/575C	2519/251D
574E	2518
57B3	2516
57B5	2D20

CCIN of SENSE DATA	Failing function code (FFC)
57B7	2504
57B8	2505
57B9	2D0B
57BA	2D0B
57C4	2D1D
57C5	2D24
57C7	2D14
57CF	2D15
57CD	2D40
2BE0	2D16
2BE1	2D17
2BD9	2D18

The second 4 digits of the SRN, known as the reason code, is equal to the next two bytes of the **SENSE DATA**.

For the Sample AIX error log for a PCI-X or PCIe controller:

- Bytes 40-43 of the **SENSE DATA** are 572C 9030.
- The first 4 digits of the SRN, using 572C in the preceding table, is 2502.
- The second 4 digits of the SRN is 9030.
- The SRN is therefore 2502 - 9030.

For the Sample AIX error log for a PCIe2 controller:

- Bytes 24-27 of the **SENSE DATA** are 57B5 9030.
- The first 4 digits of the SRN, using 57B5 in the preceding table, is 2D20.
- The second 4 digits of the SRN is 9030.
- The SRN is therefore 2D20 - 9030.

Sample AIX error log for a PCI-X or PCIe controller (Error ID = SISSAS_ARY_DEGRADED)

This is a sample AIX error log.

```
LABEL:          SISSAS_ARY_DEGRADED

IDENTIFIER:     4529BEB6


Date/Time:      Wed Sep  6 10:36:38 CDT 2006

Sequence Number: 233

Machine Id:     00CFCC1E4C00

Node Id:        x1324p1

Class:          H

Type:           TEMP

Resource Name:  sissas0

Resource Class: adapter

Resource Type:  1410c202

Location:       U787F.001.0026273-P1-C6-T1

VPD:


        Product Specific.(  ).......PCI-X266 Planar 3 Gb SAS RAID Adapter


        Part Number.................39J0180

        FRU Number..................39J0180

        Serial Number...............YL3126088109

        Manufacture ID..............0012

        EC Level....................1

        ROM Level.(alterable).......01200019

        Product Specific.(CC).......572C

        Product Specific.(Z1).......1


Description

DISK ARRAY PROTECTION SUSPENDED


        Recommended Actions

        PERFORM PROBLEM DETERMINATION PROCEDURES
```

```
Detail Data

PROBLEM DATA

0000 0800 00FF FFFF 0000 0000 0000 0000 0000 0000 1910 00F0 066B 0200 0101 0000

0120 0019 0000 0014 572C 9030 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

                   ^     ^

                   |     |

 CCIN of Controller |    | Last 4-digits of SRN

      (bytes 40-41)       (bytes 42-43)


ARRAY INFORMATION

Resource  S/N      RAID Level

00FF0100  0561513F 5


DEGRADED DISK

S/N      World Wide ID

00C8D7FA 5000CCA00308D7FA


ARRAY MEMBER INFORMATION

Expected  Actual    Vendor/

Resource  Resource  Product ID       S/N       World Wide ID

00000700  00000700  IBM      HUS15147 0017CDE5 5000CCA00317CDE5

00000300  00000300  IBM      HUS15143 00CEA6A0 5000CCA0030EA6A0

00000400  00000400  IBM      HUS15143 00C8D7FA 5000CCA00308D7FA


DDITIONAL HEX DATA

E210 0080 1400 0000 0D00 0003 2F8F 10E5 0000 0000 0000 0468 066B 0200 00FF FFFF

FFFF FFFF 1705 3003 4942 4D20 2020 2020 3537 3242 3030 3153 4953 494F 4120 2020

3036 3038 3831 3039 5005 076C 0003 0700 4942 4D20 2020 2020 3537 3242 3030 3153

4953 494F 4120 2020 3036 3038 3831 3039 5005 076C 0003 0700 0000 0002 0000 0001

00FF 0100 3035 3631 3531 3346 3500 0000 0000 0000 0000 0003 4942 4D20 2020 2020

4855 5331 3531 3437 3356 4C53 3330 3020 3030 3137 4344 4535 5000 CCA0 0317 CDE5

3433 3342 0000 0700 0000 0700 4942 4D20 2020 2020 4855 5331 3531 3433 3656 4C53

3330 3020 3030 4345 4136 4130 5000 CCA0 030E A6A0 3433 3341 0000 0300 0000 0300

4942 4D20 2020 2020 4855 5331 3531 3433 3656 4C53 3330 3020 3030 4338 4437 4641

5000 CCA0 0308 D7FA 3433 3341 0000 0400 0000 0400 0000 0000 0000 0000 0000 0000
```

Sample AIX error log for a PCIe2 controller (Error ID = VRSAS_ARY_DEGRADED)

This is a sample AIX error log for a PCIe2 controller.

```
LABEL:          VRSAS_ARY_DEGRADED

IDENTIFIER:     92BF1BD4


Date/Time:      Thu Jun  9 16:23:41 CDT 2011

Sequence Number: 1922

Machine Id:     00F61A8E4C00

Node Id:        elpar1a

Class:          H

Type:           TEMP

WPAR:           Global

Resource Name:  sissas2

Resource Class:

Resource Type:

Location:

VPD:

     PCIe2 1.8GB Cache RAID SAS Adapter Tri-port 6Gb :

       Part Number.................74Y8896

       FRU Number..................74Y7759

       Serial Number...............YL10JH116101

       Manufacture ID..............00JH

       EC Level....................0

       ROM Level.(alterable).......01500053

       Customer Card ID Number.....57B5

       Product Specific.(Z1).......1

       Product Specific.(Z2).......2D20
```

```
Description

DISK ARRAY PROTECTION SUSPENDED



     Recommended Actions

     PERFORM PROBLEM DETERMINATION PROCEDURES



Detail Data

PROBLEM DATA

0001 0800 1910 00F0 066B 0200 0101 0000 0150 0043 0000 0024 57B5 9030 0000 0000



                                              ^     ^

                                              |     |

                              CCIN of Controller |    | Last 4-digits of SRN

                                   (bytes 24-25)      (bytes 26-27)



FEFF FFFF FFFF FFFF 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 C9D7

0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000



ARRAY INFORMATION

Resource         S/N      RAID Level

FD02FFFFFFFFFFFF 00000410 5



DEGRADED DISK

S/N     World Wide ID

PMG18GUA 5000CCA0120250C8



ARRAY MEMBER INFORMATION

Expected Resource Actual Resource   Vendor   Product  S/N       World Wide ID

000408FFFFFFFFFF  000408FFFFFFFFFF  IBM      HUC10603 PMG1AHBA 5000CCA012026F14

000402FFFFFFFFFF  000402FFFFFFFFFF  IBM      HUC10603 PMG18GUA 5000CCA0120250C8

00040AFFFFFFFFFF  00040AFFFFFFFFFF  IBM      HUC10603 PMG17VBA 5000CCA01202475C
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Electronic emission notices

When attaching a monitor to the equipment, you must use the designated monitor cable and any interference suppression devices supplied with the monitor.

Class A Notices

The following Class A statements apply to the IBM servers that contain the POWER7® processor and its features unless designated as electromagnetic compatibility (EMC) Class B in the feature information.

Federal Communications Commission (FCC) statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with

the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Avis de conformité à la réglementation d'Industrie Canada

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

European Community Compliance Statement

This product is in conformity with the protection requirements of EU Council Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of non-IBM option cards.

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

European Community contact:
IBM Deutschland GmbH
Technical Regulations, Department M372
IBM-Allee 1, 71139 Ehningen, Germany
Tele: +49 7032 15 2941
email: lugi@de.ibm.com

Warning: This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

VCCI Statement - Japan

この装置は、クラスA 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。　　　　　　　　　　　　　　　　VCCI－A

The following is a summary of the VCCI Japanese statement in the box above:

This is a Class A product based on the standard of the VCCI Council. If this equipment is used in a domestic environment, radio interference may occur, in which case, the user may be required to take corrective actions.

Japanese Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guideline (products less than or equal to 20 A per phase)

高調波ガイドライン適合品

Japanese Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guideline with Modifications (products greater than 20 A per phase)

高調波ガイドライン準用品

Electromagnetic Interference (EMI) Statement - People's Republic of China

声　明
此为 A 级产品，在生活环境中、
该产品可能会造成无线电干扰。
在这种情况下，可能需要用户对其
干扰采取切实可行的措施。

Declaration: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may need to perform practical action.

Electromagnetic Interference (EMI) Statement - Taiwan

警告使用者：
這是甲類的資訊產品，在
居住的環境中使用時，可
能會造成射頻干擾，在這
種情況下，使用者會被要
求採取某些適當的對策。

The following is a summary of the EMI Taiwan statement above.

Warning: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user will be required to take adequate measures.

IBM Taiwan Contact Information:

台灣IBM 產品服務聯絡方式：
台灣國際商業機器股份有限公司
台北市松仁路7號3樓
電話：0800-016-888

Electromagnetic Interference (EMI) Statement - Korea

Germany Compliance Statement

Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse A EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2004/108/EG zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 Klasse A ein.

Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der IBM empfohlene Kabel angeschlossen werden. IBM übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung von IBM verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung von IBM gesteckt/eingebaut werden.

EN 55022 Klasse A Geräte müssen mit folgendem Warnhinweis versehen werden:
"Warnung: Dieses ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funk-Störungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen zu ergreifen und dafür aufzukommen."

Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)". Dies ist die Umsetzung der EU-Richtlinie 2004/108/EG in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC EG Richtlinie 2004/108/EG) für Geräte der Klasse A

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV Vorschriften ist der Hersteller:
International Business Machines Corp.
New Orchard Road
Armonk, New York 10504
Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:
IBM Deutschland GmbH
Technical Regulations, Abteilung M372
IBM-Allee 1, 71139 Ehningen, Germany
Tel: +49 7032 15 2941
email: lugi@de.ibm.com

Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.

Electromagnetic Interference (EMI) Statement - Russia

ВНИМАНИЕ! Настоящее изделие относится к классу А.
В жилых помещениях оно может создавать
радиопомехи, для снижения которых необходимы
дополнительные меры

Class B Notices

The following Class B statements apply to features designated as electromagnetic compatibility (EMC) Class B in the feature installation information.

Federal Communications Commission (FCC) statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an IBM-authorized dealer or service representative for help.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Proper cables and connectors are available from IBM-authorized dealers. IBM is not responsible for

any radio or television interference caused by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Compliance Statement

This Class B digital apparatus complies with Canadian ICES-003.

Avis de conformité à la réglementation d'Industrie Canada

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

European Community Compliance Statement

This product is in conformity with the protection requirements of EU Council Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of non-IBM option cards.

This product has been tested and found to comply with the limits for Class B Information Technology Equipment according to European Standard EN 55022. The limits for Class B equipment were derived for typical residential environments to provide reasonable protection against interference with licensed communication equipment.

European Community contact:
IBM Deutschland GmbH
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email: lugi@de.ibm.com

VCCI Statement - Japan

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　　取扱説明書に従って正しい取り扱いをして下さい。　　　　ＶＣＣＩ－Ｂ

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IBM Taiwan Contact Information

台灣IBM 產品服務聯絡方式：
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台北市松仁路7號3樓
電話：0800-016-888

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Germany Compliance Statement

Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse B EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2004/108/EG zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 Klasse B ein.

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Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)". Dies ist die Umsetzung der EU-Richtlinie 2004/108/EG in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC EG Richtlinie 2004/108/EG) für Geräte der Klasse B

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV Vorschriften ist der Hersteller:
International Business Machines Corp.
New Orchard Road
Armonk, New York 10504
Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:
IBM Deutschland GmbH
Technical Regulations, Abteilung M372
IBM-Allee 1, 71139 Ehningen, Germany
Tel: +49 7032 15 2941
email: lugi@de.ibm.com

Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse B.

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