Power Systems

SAS RAID controllers for Linux



Note

Before using this information and the product it supports, read the information in <u>"Safety notices" on page v</u>, <u>"Notices" on page 115</u>, the *IBM Systems Safety Notices* manual, G229-9054, and the *IBM Environmental Notices and User Guide*, Z125–5823.

This edition applies to IBM[®] Power Systems servers that contain the POWER9[™] processor and to all associated models.

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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, safety information documentation is included in the publications package (such as in printed documentation, on DVD, or as part of the product) shipped with the product. The documentation 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 documentation. You should also refer to the safety information documentation any time you do not clearly understand any safety information in the U.S. English publications.

Replacement or additional copies of safety information documentation can be obtained by calling the IBM Hotline at 1-800-300-8751.

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:

- If IBM supplied the power cord(s), 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.
 - For AC power, disconnect all power cords from their AC power source.
 - For racks with a DC power distribution panel (PDP), disconnect the customer's DC power source to the PDP.
- When connecting power to the product ensure all power cables are properly connected.
 - For racks with AC power, 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.

- For racks with a DC power distribution panel (PDP), connect the customer's DC power source to the PDP. Ensure that the proper polarity is used when attaching the DC power and DC power return wiring.
- 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.
- Do not attempt to switch on power to the machine until all possible unsafe conditions are corrected.
- Assume that an electrical safety hazard is present. Perform all continuity, grounding, and power checks specified during the subsystem installation procedures to ensure that the machine meets safety requirements.
- Do not continue with the inspection if any unsafe conditions are present.
- Before you open the device covers, unless instructed otherwise in the installation and configuration procedures: Disconnect the attached AC power cords, turn off the applicable circuit breakers located in the rack power distribution panel (PDP), and disconnect any telecommunications systems, networks, and modems.



DANGER:

• 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. For AC power, remove the power cords from the outlets.
- 3. For racks with a DC power distribution panel (PDP), turn off the circuit breakers located in the PDP and remove the power from the Customer's DC power source.
- 4. Remove the signal cables from the connectors.
- 5. 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. For AC power, attach the power cords to the outlets.
- 5. For racks with a DC power distribution panel (PDP), restore the power from the Customer's DC power source and turn on the circuit breakers located in the PDP.
- 6. Turn on the devices.

Sharp edges, corners and joints may be present in and around the system. Use care when handling equipment to avoid cuts, scrapes and pinching. (D005)

(R001 part 1 of 2):



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 if provided, unless the earthquake option is to be installed..
- 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. In addition, do not lean on rack mounted devices and do not use them to stabilize your body position (for example, when working from a ladder).



- Stability hazard:
 - The rack may tip over causing serious personal injury.
 - Before extending the rack to the installation position, read the installation instructions.
 - Do not put any load on the slide-rail mounted equipment mounted in the installation position.
 - Do not leave the slide-rail mounted equipment in the installation position.
- Each rack cabinet might have more than one power cord.
 - For AC powered racks, be sure to disconnect all power cords in the rack cabinet when directed to disconnect power during servicing.
 - For racks with a DC power distribution panel (PDP), turn off the circuit breaker that controls the power to the system unit(s), or disconnect the customer's DC power source, 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. (R001 part 1 of 2)

(R001 part 2 of 2):



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 or if the rack is not bolted to the floor. 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 part 2 of 2)



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 little-to-no empty U-levels between devices installed in the rack cabinet below the 32U level, unless the received configuration specifically allowed it.
- If the rack cabinet you are relocating is part of a suite of rack cabinets, detach the rack cabinet from the suite.
- If the rack cabinet you are relocating was supplied with removable outriggers they must be reinstalled before the cabinet is relocated.
- 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 2083 mm (30 x 82 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 or in an earthquake environment bolt the rack to the floor.
 - 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)



DANGER: Hazardous voltage, current, or energy levels are present inside any component that has this label attached. Do not open any cover or barrier that contains this label. (L001)

(L002)



DANGER: Rack-mounted devices are not to be used as shelves or work spaces. Do not place objects on top of rack-mounted devices. In addition, do not lean on rack-mounted devices and do not use them to stabilize your body position (for example, when working from a ladder). Stability hazard:

- The rack may tip over causing serious personal injury.
- Before extending the rack to the installation position, read the installation instructions.
- Do not put any load on the slide-rail mounted equipment mounted in the installation position.
- Do not leave the slide-rail mounted equipment in the installation position.
- (L002)

(L003)



or



or



or





(L007)





CAUTION: A hot surface nearby. (L007)

(L008)





CAUTION: Hazardous moving parts nearby. (L008)

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. Although shining light into one end and looking into the other end of a disconnected optical fiber to verify the continuity of optic fibers may not injure the eye, this procedure is potentially dangerous. Therefore, verifying the continuity of optical fibers by shining light into one end and looking at the other end is not recommended. To verify continuity of a fiber optic cable, use an optical light source and power meter. (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)

(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 degrees C (212 degrees 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)



CAUTION: Regarding IBM provided VENDOR LIFT TOOL:

• Operation of LIFT TOOL by authorized personnel only.

- LIFT TOOL intended for use to assist, lift, install, remove units (load) up into rack elevations. It is not to be used loaded transporting over major ramps nor as a replacement for such designated tools like pallet jacks, walkies, fork trucks and such related relocation practices. When this is not practicable, specially trained persons or services must be used (for instance, riggers or movers).
- Read and completely understand the contents of LIFT TOOL operator's manual before using. Failure to read, understand, obey safety rules, and follow instructions may result in property damage and/or personal injury. If there are questions, contact the vendor's service and support. Local paper manual must remain with machine in provided storage sleeve area. Latest revision manual available on vendor's web site.
- Test verify stabilizer brake function before each use. Do not over-force moving or rolling the LIFT TOOL with stabilizer brake engaged.
- Do not raise, lower or slide platform load shelf unless stabilizer (brake pedal jack) is fully engaged. Keep stabilizer brake engaged when not in use or motion.
- Do not move LIFT TOOL while platform is raised, except for minor positioning.
- Do not exceed rated load capacity. See LOAD CAPACITY CHART regarding maximum loads at center versus edge of extended platform.
- Only raise load if properly centered on platform. Do not place more than 200 lb (91 kg) on edge of sliding platform shelf also considering the load's center of mass/gravity (CoG).
- Do not corner load the platforms, tilt riser, angled unit install wedge or other such accessory options. Secure such platforms -- riser tilt, wedge, etc options to main lift shelf or forks in all four (4x or all other provisioned mounting) locations with provided hardware only, prior to use. Load objects are designed to slide on/off smooth platforms without appreciable force, so take care not to push or lean. Keep riser tilt [adjustable angling platform] option flat at all times except for final minor angle adjustment when needed.
- Do not stand under overhanging load.
- Do not use on uneven surface, incline or decline (major ramps).
- Do not stack loads.
- Do not operate while under the influence of drugs or alcohol.
- Do not support ladder against LIFT TOOL (unless the specific allowance is provided for one following qualified procedures for working at elevations with this TOOL).
- Tipping hazard. Do not push or lean against load with raised platform.
- Do not use as a personnel lifting platform or step. No riders.
- Do not stand on any part of lift. Not a step.
- Do not climb on mast.
- Do not operate a damaged or malfunctioning LIFT TOOL machine.
- Crush and pinch point hazard below platform. Only lower load in areas clear of personnel and obstructions. Keep hands and feet clear during operation.
- No Forks. Never lift or move bare LIFT TOOL MACHINE with pallet truck, jack or fork lift.
- Mast extends higher than platform. Be aware of ceiling height, cable trays, sprinklers, lights, and other overhead objects.
- Do not leave LIFT TOOL machine unattended with an elevated load.
- Watch and keep hands, fingers, and clothing clear when equipment is in motion.
- Turn Winch with hand power only. If winch handle cannot be cranked easily with one hand, it is probably over-loaded. Do not continue to turn winch past top or bottom of platform travel. Excessive unwinding will detach handle and damage cable. Always hold handle when lowering, unwinding. Always assure self that winch is holding load before releasing winch handle.
- A winch accident could cause serious injury. Not for moving humans. Make certain clicking sound is heard as the equipment is being raised. Be sure winch is locked in position before releasing handle. Read instruction page before operating this winch. Never allow winch to unwind freely.

Freewheeling will cause uneven cable wrapping around winch drum, damage cable, and may cause serious injury.

• This TOOL must be maintained correctly for IBM Service personnel to use it. IBM shall inspect condition and verify maintenance history before operation. Personnel reserve the right not to use TOOL if inadequate. (C048)

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.

The dc-powered system is intended to be installed in a common bonding network (CBN) as described in GR-1089-CORE.

xiv Power Systems:

SAS RAID controllers for Linux

The PCI Express (PCIe) serial-attached SCSI (SAS) RAID controller is available for various versions of the Linux[®] kernel. Learn how to use and maintain the controller.

General information

This section provides general information about the IBM SAS RAID controllers for Linux.

The controllers have the following features:

- Supports SAS devices and non-disk Serial Advanced Technology Attachment (SATA) devices.
- Optimized for SAS disk configurations which utilize dual paths thru 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).
- Supports nonvolatile write cache for RAID disk arrays on some adapters.
- Support for RAID 0, 5, 6, 10, 5T2, 6T2, and 10T2 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, 10, 5T2, 6T2, and 10T2 disk arrays
 - Ability to increase the capacity of an existing RAID 5 or 6 disk array by adding disks
 - Background parity checking
 - Background data scrubbing
 - Disks formatted to 528 or 4224 bytes per sector, providing SCSI T10 standardized data integrity fields along with logically bad block checking on PCIe3 controllers
 - Optimized hardware for RAID 5 and 6 sequential write workloads
 - Optimized skip read/write disk support for transaction workloads
 - Support for a maximum of 240 advanced function disks with a maximum of 1023 total devices on PCIe3 controllers

Note: The number of all physical SAS and SATA devices plus the number of logical RAID disk arrays must be less than 1023 per controller.

• 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).

Note: This information refers to various hardware and software features and functions. The realization of these features and functions depends on the limitations of your hardware and software. The Linux operating system supports all functions mentioned. If you are using another operating system, consult the appropriate documentation for that operating system regarding support for the mentioned features and functions.

Related reference

Related information

Many other sources of information about the Linux operating system, RAID, and other associated topics are available.

References to the Linux operating system

Three different versions of the Linux operating system are referred to in this topic collection.

Feature comparison of SAS RAID cards

Compare the main features of PCI Express (PCIe) and PCIe3 SAS RAID cards.

These tables provides a breakdown of the main features of the SAS RAID PCIe controller cards.

PCIe SAS RAID card comparison

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

| Table 1. PCIe SAS RAID controller cards | | | | | |
|--|--------------------------------------|--|--|--|--|
| CCIN (custom card identification number) | 57 B 3 | | | | |
| Description | PCIe x8 Ext Dual-x4 3 Gb SAS Adapter | | | | |
| Form factor | PCIe x8 | | | | |
| Adapter failing function code LED value | 2516 | | | | |
| Physical links | 8 (two mini SAS 4x connectors) | | | | |
| Supports removable media devices only (Tape / DVD) | Yes | | | | |
| Requires HA RAID configuration | No | | | | |
| JBOD support | Yes | | | | |
| 520-byte virtual disk support | No | | | | |



Figure 1. CCIN 57B3 PCIe x8 Ext Dual-x4 3 Gb SAS adapter

PCIe3 SAS RAID card comparison This table compares the main features of PCI Express 3.0 (PCIe3) SAS RAID cards.

| Table 2. PCIe3 SAS RAID controller cards | | | | | | |
|--|--|---|--|---|---|---|
| CCIN (custom card identification number) | 57 B 1 | 57B4 | 57CE | 57D7 | 57D8 | 57DC |
| Description | PCIe3 12 Gb Cache RAID+ SAS adapter Quad-port 6 Gb | PCIe3 RAID SAS adapter Quad-port 6 Gb x8 | PCIe3 12 GB Cache RAID SAS adapter Quad-port 6 Gb x8 | PCIe3 x8 SAS RAID internal adapter 6 Gb | PCIe3 x8 Cache SAS RAID internal adapter 6 Gb | PCIe3 x8 Cache SAS RAID internal adapter 6 Gb |
| Form factor | PCIe3 x8 | PCIe3 x8 | PCIe3 x8 | Planar-unique PCIe3 x8 | Planar-unique PCIe3 x8 | Planar-unique PCIe3 x8 |
| Adapter failing function code LED value | 2D22 | 2D11 | 2D21 | 2D35 | 2D36 | 2D36 |
| Physical links | 16 (four mini SAS HD 4x connectors | 16 (four mini SAS HD 4x connectors) | 16 (four mini SAS HD 4x connectors) | 16 (internal connection to directly attached SAS drives) | 16 (internal connections to directly attached SAS drives and remote adapter link) and 4 (one mini SAS HD 4x connector for external SAS attach) | 16 (internal connections to directly attached SAS drives and remote adapter link) and 4 (one mini SAS HD 4x connector for external SAS attach) |
| Supported RAID levels | RAID 0, 5, 6, 10, 5T2, 6T2, and 10T2 | RAID 0, 5, 6, 10 | RAID 0, 5, 6, 10, 5T2, 6T2, and 10T2 | RAID 0, 5, 6, 10 | RAID 0, 5, 6, 10, 5T2, 6T2, and 10T2 | RAID 0, 5, 6, 10 |
| Write cache size | Up to 12 GB (compressed) | Up to 1 GB (compressed) (disabled for HA RAID configurations) | Up to 12 GB (compressed) | Up to 1 GB (compressed) | Up to 7.2 GB (compressed) | Up to 7.2 GB (compressed) |
| Cache battery pack technology | None (uses supercapacito r technology) | None (uses synchronize cache) | None (uses supercapacitor technology) | None (uses synchronize cache) | None (uses supercapacitor technology) | None (uses supercapacitor technology) |
| High-availability (HA) two-system RAID | No | Yes ⁴ | Yes | No | Yes | No |
| HA two-system JBOD | No | No | No | No | No | No |
| Auxiliary write cache (AWC) support | No | No | No | No | No | No |
| HA single-system RAID | Yes | Yes ⁴ | Yes | No | Yes | No |
| Requires HA RAID configuration | Yes | No | Yes | No | Yes | No |
| JBOD SAS disk support | No | Yes ² | No | Yes ² | No | No |
| SAS tape support | No | Yes ¹ | No | No | No | No |
| SATA DVD support | No | Yes ¹ , ³ | No | Yes | Yes | No |
| Native 4K block device support | Yes | Yes | Yes | Yes | Yes | Yes |
| Easy Tier® function | | No | Yes | No | Yes | No |

| Table 2. PCIe3 SAS RAID controller cards (continued) | | | | | | |
|--|------|------|------|------|------|------|
| CCIN (custom card identification number) | 57B1 | 57B4 | 57CE | 57D7 | 57D8 | 57DC |
| Note: | | | | | | |

Note:

1. SAS tape and SATA DVD is only supported in a single adapter configuration and cannot be mixed with SAS disk on the same adapter.

2. JBOD is not supported on SSDs or if the adapters are configured as high availability (HA) RAID.

- SATA DVD is supported on all CCIN 57B4 adapters, except for those with initial part numbers of either 00FX843, 00MH900, 00FX846, or 00MH903.
- 4. Feature code EJOK does not support high-availability (HA) RAID when the adapters are installed in PCIe slots C9 or C12 on 9040-MR9 POWER9 systems.



Figure 2. CCIN 57B1 PCIe3 12 GB cache RAID+ SAS adapter Quad-port 6 Gb x8



Figure 3. CCIN 57B4 PCIe3 RAID SAS adapter Quad-port 6 Gb x8, four units



Figure 4. CCIN 57B4 PCIe3 RAID SAS adapter Quad-port 6 Gb x8, two units



Figure 5. CCIN 57CE PCIe3 12 GB cache RAID SAS adapter Quad-port 6 Gb x8



Figure 6. CCIN 57D7 PCIe3 x8 SAS RAID internal adapter 6 Gb



Figure 7. CCIN 57D8 PCIe3 x8 Cache SAS RAID internal adapter 6 Gb



Figure 8. CCIN 57D8 and 57DC PCIe3 x8 Cache SAS RAID internal adapter 6 Gb

References to the Linux operating system

Three different versions of the Linux operating system are referred to in this topic collection.

References to the Linux operating system in this topic collection include the Linux kernel versions 2.6, and later, SUSE Linux Enterprise Server 10, SUSE Linux Enterprise Server 11, Red Hat Enterprise Linux 4, Red Hat Enterprise Linux 5, and Red Hat Enterprise Linux 6. Make sure you are consulting the appropriate section of this topic collection for the operating system you are using.

This document might describe hardware features and functions. While the hardware supports them, the realization of these features and functions depends upon support from the operating system. The Linux operating system provides this support. If you are using another operating system, consult the appropriate documentation for that operating system regarding support for those features and functions.

Related information

Many other sources of information about the Linux operating system, RAID, and other associated topics are available.

The following publications contain related information:

- System unit documentation for information specific to your hardware configuration
- The IPR Linux device driver website
- *RS/6000[®] eServer[™] pSeries Adapters, Devices, and Cable Information for Multiple Bus Systems*, order number SA38-0516 (http://www-01.ibm.com/support/docview.wss?uid=pub1sa38051616)
- The Linux Documentation Project website
- The Linux for IBM eServer pSeries website

- *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*, order number SA38-0509 (http://www-01.ibm.com/support/docview.wss?uid=pub1sa38050923)
- The RAIDbook: A Handbook of Storage Systems Technology, Edition 6, Editor: Paul Massiglia
- The <u>OpenPOWER</u> website and <u>IBM developerWorks[®]</u> website for information about Linux on PowerPC architecture

SAS overview

The term Serial-attached SCSI (SAS) refers to a set of serial device interconnect and transport protocols.

This set of protocols 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 *ports*. A port contains one or more physical links. A port is a *wide* port if there are multiple physical links in the port. A port is a *narrow* port if there is only one physical link in the port. A port is identified by a unique SAS worldwide name (also called a SAS address). A 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 using either the SCSI command set or the ATA/ATAPI command set, depending on the device type.

An *expander* facilitates connections between a controller port and multiple I/O device ports. An expander routes connections between the expander ports. There is only a single connection through an expander 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, then it is possible to have more than one path to the device when there are expander devices on the path.

A SAS *fabric* refers to the summation of all paths between all controller ports and all I/O device ports in the SAS subsystem.

SAS architecture summary

Elements that interact to enable the structure of the SAS architecture include controllers, ports, and expanders.

The following points are applicable to this description of general SAS architecture:

- A SAS fabric describes all possible paths between all SAS controllers and I/O devices including cables, enclosures and expanders.
- A SAS controller, expander and I/O device contains one or more SAS ports.
- A SAS port contains one or more physical links.
- A SAS path is a logical connection between a SAS controller port and I/O device ports.
- SAS devices use the SCSI command set and SATA devices use the ATA/ATAPI command set.



Figure 9. Example of the SAS subsystem

The example of a SAS subsystem in the preceding figure illustrates some general concepts.

This controller has eight SAS physical link connections. Four of those physical links are connected into two different wide ports. (One connector contains four physical links grouped into two ports; the connectors signify a physical wire connection.) The four-physical link connector can contain between one and four ports depending on the type of cabling used.

The uppermost port in the figure shows a controller wide port number 6 consisting of physical link numbers 6 and 7. Port 6 connects to an expander which attaches to one of the I/O devices dual ports.

The dashed red line indicates a path between the controller and an I/O device. There is another path from the controller's port number 4 to the other port of the I/O device. These two paths provide two different possible 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.

Disk arrays

RAID technology is used to store data across a group of disks known as a disk array.

Depending on the RAID level selected, the technique of storing data across a group of disks provides the data redundancy required to keep data secure and the system operational. If a disk failure occurs, the disk can usually be replaced without interrupting normal system operation. Disk arrays also have the potential to provide higher data transfer and input and output (I/O) rates than those provided by single large disks.

Each disk array can be used by the Linux operating system in the same way as it would a single SCSI disk. For example, after creating a disk array, you can use Linux commands to make the disk array available to the system by partitioning and creating file systems on it.

A tier is a grouping of physical disks within an Easy Tier disk array all of which have the same performance characteristics. For example, an Easy Tier disk array may contain a tier of SSDs and a tier of HDDs. A data band is the block of data in an Easy Tier disk array that is being analyzed for I/O activity. This data band is the block of data that may move between tiers to better match the I/O activity within the band with the performance characteristics of the tier. The size of the data band can be 1 MB to 8 MB in size depending on the configuration of the Easy Tier disk array.

The SAS controller and I/O devices are managed by the iprconfig utility. The iprconfig utility is the interface to the RAID configuration, monitoring, and recovery features of the controller and I/O devices.

If a disk array is to be used as the boot device, it might be necessary to prepare the disks by booting into Rescue mode and creating the disk array before installing the Linux operating system. You might want to perform this procedure when the original boot drive is to be used as part of a disk array.

The following figure illustrates a possible disk array configuration.



Figure 10. Disk array configuration

Easy Tier function

Easy Tier function works with specific RAID levels (i.e., 5T2, 6T2, and 10T2) that support grouping disks with different performance characteristics but similar RAID block formats into tiers within a single array. The Easy Tier function automatically optimizes storage performance across the tiers by moving the physical data placement between the tiers while keeping the external disk view of the Disk array logical block locations unchanged. The Easy Tier function logically divides the Disk array into data bands and continually analyzes the I/O activity in each band. Based on the current I/O activity in each band, the Easy Tier function optimizes performance and resource utilization by automatically and non-disruptively swapping data bands between physical disk tiers containing the most appropriate performance characteristics for the current I/O activity in the band (for example, moving the hottest data to fastest tier.) The tiers are automatically organized such that the best performing tier aligns with disk array LBA 0 (the beginning of the array) when a new array is created before any of the data bands become swapped. It is important to note that a hot-spare disk only replaces a disk in the tier that has the similar performance characteristics as the hot-spare disk. Therefore, you need different hot-spare disks to fully cover all tiers in a tiered RAID level. For example, an SSD hot-spare and a HDD hot-spare disk.

Easy Tier function supports tiers with different performance characteristics by using the following disk drive technologies:

- SSDs that have a high write endurance
- Mainstream SSDs that are intended to be used for read-intensive workloads
- HDDs or Enterprise Nearline (ENL) HDDs

A tiered RAID array might be created with the following combinations of disk drive technologies:

- SSDs and HDDs
- Mainstream SSDs and HDDs
- SSDs and ENL HDDs
- Mainstream SSDs and ENL HDDs

When SSDs are used with HDDs in a tiered RAID array, hot data is the frequently accessed read data and write data, and will be moved to the SSDs. However, when Mainstream SSDs are used with HDDs in a tiered RAID array, hot data is only the frequently accessed read data and will be moved to the Mainstream SSDs, while frequently accessed write data will be moved to the HDDs. This policy enables Mainstream SSDs to maintain the reliability for a long time even when write-intensive workloads exist. When using RAID adapters that have a write cache, write performance is likely to be very good, irrespective of whether the write data is placed on SSDs, Mainstream SSDs, or HDDs.

Notes:

- All tiers in the Easy Tier array must contain devices with the same block size. All the SSDs and HDDs in the array must either be 528 bytes per sector or 4224 bytes per sector.
- Each tier in an Easy Tier array must contain at least 10% of the total disk capacity. For more information, see "Estimating disk array capacities" on page 20.

Supported RAID levels

The level of a disk array refers to the manner in which data is stored on the disk and the level of protection that is provided.

The RAID level of a disk array determines how data is stored on the disk array and the level of protection that is provided. When a part of the RAID system fails, different RAID levels help to recover lost data in different ways. With the exception of RAID 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 disks within the array. This data reconstruction has little or no impact to current system programs and users. The SAS RAID controller supports RAID 0, 5, 6, and 10. Not all controllers support all RAID levels. See the <u>"Feature comparison of SAS RAID cards" on page 2</u> table for more information. Each RAID level supported by the SAS RAID controller has its own attributes and uses a different method of writing data. The following information details each supported RAID level.

Related concepts

RAID 0

RAID 0 stripes data across the disks in the array for optimal performance.

RAID 5

RAID 5 stripes data across all disks in the array.

RAID 6

RAID 6 stripes data across all disks in the array.

RAID 10

RAID 10 uses mirrored pairs to redundantly store data.

RAID 0

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 11. 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.

Related concepts

Supported RAID levels

The level of a disk array refers to the manner in which data is stored on the disk and the level of protection that is provided.

RAID 5

RAID 5 stripes data across all disks in the array.

In addition to data, RAID 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 are written in the following pattern:



Figure 12. RAID 5

If a disk fails in a RAID 5 array, you can continue to use the array normally. A RAID 5 array 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 will be placed in the failed state and will not be accessible.

Related concepts

Supported RAID levels

The level of a disk array refers to the manner in which data is stored on the disk and the level of protection that is provided.

RAID 6

RAID 6 stripes data across all disks in the array.

In addition to data, RAID 6 also writes array P and Q parity data. The P and Q parity data, which is based on Reed Solomon algorithms, is spread across all the disks. For a RAID 6 array of four disks, array data and parity information are written in the following pattern:



Figure 13. 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 operating with 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 will be placed in the failed state and will not be accessible.

Related concepts

Supported RAID levels

The level of a disk array refers to the manner in which data is stored on the disk and the level of protection that is provided.

RAID 10

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 that you need to create a RAID 10 array. A two-disk RAID 10 array is equal to a RAID 1 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 14. RAID 10

RAID 10 can tolerate multiple disk failures. If one disk in each mirrored pair fails, the array is still 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.

Related concepts

Supported RAID levels

The level of a disk array refers to the manner in which data is stored on the disk and the level of protection that is provided.

RAID 5T2

Learn how data is written to a RAID 5T2 array when using the Easy Tier function.

RAID 5T2 is a RAID level that provides RAID 5 protection when using the Easy Tier function utilizing two different tiers of physical disk that have unique performance characteristics. Each tier functions as a single redundancy group and stripes data across all disks in the tier. Each tier is RAID 5 protected and writes array parity data across all the disks in the tier. For a RAID 5T2 array that has one tier of three SSD disks and another tier of four HDD disks, array data and parity information is written in the following pattern:

RAID 5T2 Array Disk 1 Disk 2 Disk 3 Disk 4 Disk 5 Disk 6 Disk 7 Parity Stripe Unit Stripe Unit Parity Stripe Unit 1 Stripe Unit Unit 3 Stripe Stripe Unit 3 Parity Stripe Unit Stripe Unit Parity Stripe Unit 5 Stripe Unit 6 Unit 5 Unit Unit § Stripe Unit 6 Parity Stripe Stripe Unit 8 Parity Stripe Stripe 0 • • 0 P9EBK501-0 RAID 5 SSD disks in Array Tier 0 RAID 5 HDD disks in Array Tier 1 i

Figure 15. RAID 5T2

If a disk fails in either RAID 5 tier, you can continue to use the entire array. Each tier can contain a failed disk and the array continues to function. A RAID 5T2 array that is operating with a single failed disk in either or both tiers 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 in either tier, the entire array is placed in the failed state and is not accessible.

RAID 6T2

Learn how data is written to a RAID 6T2 array when using the Easy Tier function.

RAID 6T2 is a RAID level that provides RAID 6 protection when using the Easy Tier function utilizing two different tiers of physical disk that have unique performance characteristics. Each tier functions as a single redundancy group and stripes data across all disks in the tier. Each tier is RAID 6 protected and writes P and Q parity data across all the disks in the tier. For a RAID 6T2 array that has one tier of four SSD disks and another tier of 5 HDD disks, array data and parity information is written in the following pattern:





If one or two disks fail in either RAID 6 tier, you can continue to use the entire array normally. A RAID 6T2 array that is operating with one or two failed disks in either or both tiers 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 tier in a RAID 6T2 array with a single failed disk has similar protection as that of a RAID 5 array with no disk failures. If a third disk fails in either tier, the entire array is placed in the failed state and is not be accessible.

RAID 10T2

Learn how data is written to a RAID 10T2 array when using the Easy Tier function.

RAID 10T2 is a RAID level that provides RAID 10 mirrored pair redundancy when using the Easy Tier function utilizing two different tiers of physical disk that have unique performance characteristics. Each tier must contain an even number of disks. A minimum of two disks are needed to create a RAID 10T2 tier. The data is striped across the mirrored pairs in each tier. For example, a RAID 10T2 array that has one tier of four SSD disks and another tier of 6 HDD disks would have data written on it in the following pattern:



Figure 17. RAID 10T2

RAID 10T2 tolerates multiple disk failures. If one disk in each mirrored pair fails, the array continues to function, operating in degraded mode. You can continue to use the array 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 10T2 disk array is created, the controller automatically attempts 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 a disk array are located on one of the controller connectors and another four disks selected are located on another of the controller connectors, the controller automatically attempts to create each mirrored pair from one disk on each controller connector. In the case of a controller port, cable, or enclosure failure, each mirrored pair continues to operate in a degraded mode. Such redundancy requires careful planning when you are determining where to place devices.

Estimating disk array capacities

The capacity of a disk array depends on the capacity of the advanced function disks used and the RAID level of the array.

Before you begin

In order to estimate the capacity of a disk array, you must know the capacity of the advanced function disks and the RAID level of the array.

Procedure

- 1. For RAID 0, multiply the number of disks by the disk capacity.
- 2. For RAID 5, multiply one fewer than the number of disks by the disk capacity.
- 3. For RAID 6, multiply two fewer than the number of disks by the disk capacity.
- 4. For 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.
- SAS RAID controllers support up to 18 member disks in each RAID array.
- 5. For RAID 5T2, 6T2, and 10T2, each tier in the array follows the capacity rules for the base RAID level of the tier. Note that each tier must contain at least 10% of the total disk capacity. The disk capacity per tier is calculated by taking the smallest drive in each tier multiplied by the total number of physical disks in that tier. Divide the disk capacity of each tier by the total disk capacity. The result must be greater than 10%.

Related concepts

RAID level summary

Compare RAID levels according to their capabilities.

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 3. RAID level summary | | | | | | |
|-----------------------------|-----------------|----------------------|------------------|-------------------|--|--|
| RAID level | Data redundancy | Usable disk capacity | Read performance | Write performance | Min/Max devices per array on PCIe3 controllers | |
| RAID 0 | None | 100% | Very good | Excellent | 1/32 | |
| RAID 5 | Very good | 67% to 94% | Very good | Good | 3/32 | |
| RAID 6 | Excellent | 50% to 89% | Very good | Fair to good | 4/32 | |
| RAID 10 | Excellent | 50% | Excellent | Very good | 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.

RAID 5T2, 6T2, and 10T2

Each tier in the array follows the capabilities of the base RAID level of the tier, except that the total maximum number of devices in both tiers combined cannot exceed the max number of devices for that base RAID level.

Related tasks

Estimating disk array capacities

The capacity of a disk array depends on the capacity of the advanced function disks used and the RAID level of the array.

Stripe-unit size

With RAID technology, data is striped across an array of physical disks.

Striping data across an array of physical disks complements the way 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 PCIe3 controllers, you can only set a stripe-unit size of 256 KB. This stripe-unit size provides the optimum performance when used with both HDDs and SSDs. The recommended stripe size for most applications is 256 KB.

Disk array overview

Disk arrays are groups of disks that work together with a specialized array controller to potentially achieve higher data transfer and input and output (I/O) rates than those provided by single large disks.

The 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.

Note: This topic and the **iprconfig** utility use common terminology for disk formats:

• JBOD

A Just a Bunch Of Disks (JBOD) disk is formatted to 512 or 4096 bytes per sector. A JBOD disk is assigned a /dev/sdX name and can be used by the Linux operating system.

Advanced function

An *advanced function* disk is formatted to 528 or 4224 bytes per sector. This format allows disks to be used in disk arrays. An advanced function disk cannot be used by the Linux operating system directly. The Linux operating system can use an advanced function disk only if it is configured into a disk array.

Disk arrays are accessed in the Linux operating system as standard SCSI disk devices. These devices are automatically created when a disk array is created, and deleted whenever a disk array is deleted. The individual physical disks that comprise disk arrays (or are candidates to be used in disk arrays), which are formatted for advanced function, are hidden from Linux operating system and are accessible only through the iprconfig utility. The Linux operating system sees all JBOD disks. These disks must be formatted for advanced function before they can be used in disk arrays. For information on formatting JBOD disks to make them available for use in disk arrays, see "Formatting to JBOD" on page 33.

An advanced function disk can be configured as:

Array Member

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

Hot Spare

A 528 bytes per sector HDD disk that can be used by the controller to automatically replace a Failed disk in a Degraded RAID 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 <u>"Hot-spare disks" on page 36</u>.

Array Candidate

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

SSD Array Member

A 528 bytes per sector Solid-State disk that is configured as a member of an array.

SSD Hot Spare

A 528 bytes per sector Solid-State disk that can be used by the controller to automatically replace a Failed disk in a Degraded RAID 5, 6, 10, 5T2, 6T2, or 10T2 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 "Hot-spare disks" on page 36.
SSD Array Candidate

A 528 bytes per sector solid-state disk that is a candidate for becoming an Array Member or a Hot Spare.

RI (Mainstream) Array Member

A 528 bytes per sector read intensive (RI) solid-state disk that is configured as a member of an array.

RI (Mainstream) Hot Spare

A 528 bytes per sector read intensive (RI) solid-state disk that can be used by the controller to automatically replace a failed RI/Mainstream disk in a degraded RAID 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 <u>"Hot-spare disks" on page 36</u>.

RI (Mainstream) Array Candidate

A 528 bytes per sector read intensive (RI) solid-state disk that is a candidate for becoming an array member or a hot-spare disk in an array.

4K Array Member

A 4224 bytes per sector HDD disk that is configured as a member of an array.

4K Hot Spare

A 4224 bytes per sector HDD disk that can be used by the controller to automatically replace a Failed disk in a Degraded RAID 5, 6, 10, 5T2, 6T2, or 10T2 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 "Hot-spare disks" on page 36.

4K Array Candidate

A 4224 bytes per sector HDD disk that is a candidate for becoming an Array Member or a Hot Spare.

4K SSD Array Member

A 4224 bytes per sector Solid-State disk that is configured as a member of an array.

4K SSD Hot Spare

A 4224 bytes per sector Solid-State disk that can be used by the controller to automatically replace a failed disk in a Degraded RAID 5, 6, 10, 5T2, 6T2, or 10T2 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 "Hot-spare disks" on page 36.

4K SSD Array Candidate

A 4224 bytes per sector Solid-State disk that is a candidate for becoming an Array Member or a Hot Spare.

4K RI (Mainstream) Array Member

A 4224 bytes per sector read intensive (RI) solid-state pdisk that is configured as a member of an array.

4K RI (Mainstream) Hot Spare

A 4224 bytes per sector read intensive (RI) solid-state pdisk that can be used by the controller to automatically replace a failed RI disk in a degraded RAID 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 "Hot-spare disks" on page 36.

4K RI (Mainstream) Array Candidate

A 4224 bytes per sector read intensive (RI) solid-state pdisk that is a candidate for becoming an array member or a hot-spare disk for in an array.

4K ENL Array Member

A 4224 bytes per sector Enterprise Nearline (ENL) hard disk drive (HDD) pdisk that is configured as a member of an array.

4K ENL Hot Spare

A 4224 bytes per sector ENL HDD pdisk that can be used by the controller to automatically replace a failed ENL disk in a degraded RAID disk array. A hot-spare disk is useful only if the 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 <u>"Hot-spare disks"</u> on page 36.

4K ENL Array Candidate

A 4224 bytes per sector ENL HDD pdisk that is a candidate for becoming an array member or a Hot Spare disk in an array.

The **Display Hardware Status** option in the iprconfig utility can be used to display these disks and their associated resource names. For details regarding how to view the disk information, see <u>"Viewing device status"</u> on page 29. The following sample output is displayed when the **Display Hardware Status** option is invoked:

| + | | | | | | | | | |
|------|-------------------------|---|------------------------|-------------|--|--|--|--|--|
| | Display Hardware Status | | | | | | | | |
| ITvn | Type option press Enter | | | | | | | | |
| 1 1: | =Displa | v hardware resource informa | tion details | | | | | | |
| i - | 220020 | , | | | | | | | |
| OPT | Name | PCI/SCSI Location | Description | Status | | | | | |
| | | | | | | | | | |
| 1 | | 0000:00:01.0/0: | PCI-X SAS RAID Adapter | Operational | | | | | |
| | sda | 0000:00:01.0/0:4:2:0 | Physical Disk | Active | | | | | |
| | sdb | 0000:00:01.0/0:4:5:0 | Physical Disk | Active | | | | | |
| 1 | | 0000:00:01.0/0:4:10:0 | Enclosure | Active | | | | | |
| ! | | 0000:00:01.0/0:6:10:0 | Enclosure | Active | | | | | |
| | | | Enclosure | Active | | | | | |
| - | odo | | PUI-X SAS RAID Adapter | Uperational | | | | | |
| - | SUC | | Physical Disk | Active | | | | | |
| - | suu | | Advanced Eurotion Dick | Active | | | | | |
| 1 | | 0002.00.01.0/1.0.4.0 | Advanced Function Disk | Active | | | | | |
| 1 | | 0002.00.01.0/1.0.0.0 | Advanced Function Disk | Active | | | | | |
| ł | | 0002.00.01.0/1.0.0.0 | Hot Snare | Active | | | | | |
| i | sde | 0002:00:01 0/1:255:0:0 | RATD 0 Disk Array | Active | | | | | |
| i | 040 | $0002 \cdot 00 \cdot 01 0/1 \cdot 0 \cdot 0 \cdot 0$ | RATD 0 Array Member | Active | | | | | |
| i | sdf | 0002:00:01.0/1:255:1:0 | RAID 6 Disk Array | Active | | | | | |
| i | | 0002:00:01.0/1:0:10:0 | RAID 6 Arrav Member | Active | | | | | |
| İ | | 0002:00:01.0/1:0:11:0 | RAID 6 Array Member | Active | | | | | |
| Ì | | 0002:00:01.0/1:0:8:0 | RAID 6 Array Member | Active | | | | | |
| 1 | | 0002:00:01.0/1:0:9:0 | RAID 6 Array Member | Active | | | | | |
| | | 0002:00:01.0/1:0:24:0 | Enclosure | Active | | | | | |
| | | 0002:00:01.0/1:2:24:0 | Enclosure | Active | | | | | |
| _ | | | -1 | | | | | | |
| e=E: | xıt q | =Cancel r=Reiresh t=Tog | g⊥e | | | | | | |

Disk array, physical disk, and I/O adapter (IOA) states are displayed in the fifth column of the **Display Hardware Status** screen.

Disk array states

A disk array can be in one of seven states.

The seven valid states for disk arrays are described in the following table:

| Table 4. Disk array | Table 4. Disk array states | | | | |
|--|--|--|--|--|--|
| State | Description | | | | |
| Active | The disk array is functional and fully protected (RAID level 5, 6, 10, 5T2, 6T2, and 10T2) with all physical disks in the Active state. | | | | |
| Degraded The disk array's protection against disk failures is degraded or its perfo degraded. | | | | | |
| | When one or more physical disks in the disk array are in the Failed state, the array is still functional but might no longer be fully protected against disk failures. The Degraded state indicates the protection against disk failures is less than optimal. | | | | |
| | When all physical disks in the disk array are in the Active state, the array is not performing optimally because of a problem with the I/O adapter's nonvolatile write cache. The Degraded state indicates the performance is less than optimal. | | | | |
| Rebuilding | Data protection is being rebuilt on this disk array. | | | | |

| Table 4. Disk array states (continued) | | | | | |
|--|--|--|--|--|--|
| State | Description | | | | |
| R/W Protected | The disk array cannot process a read nor write operation. A disk array may be in this state because of a cache, device configuration, or any other problem that could cause a data integrity exposure. | | | | |
| Missing | The disk array was not detected by the host operating system. | | | | |
| Offline | The disk array has been placed offline due to unrecoverable errors. | | | | |
| Failed | The disk array is no longer accessible because of disk failures or configuration problems. | | | | |

Related concepts

I/O adapter states

There are three possible states for the I/O adapter.

Physical disk states

There are six possible states for the physical disks.

Physical disk states

There are six possible states for the physical disks.

The six possible states for physical disks are described in the following table:

| Table 5. Physical disk states | | | | |
|-------------------------------|--|--|--|--|
| State | Description | | | |
| Active | The disk is functioning properly. | | | |
| Failed | The IOA cannot communicate with the disk or the disk is the cause of the disk array being in the degraded state. | | | |
| Offline | The disk array has been placed offline due to unrecoverable errors. | | | |
| Missing | The disk was not detected by the host operating system. | | | |
| R/W Protected | The device cannot process a read nor write operation. A disk may be in this state because of a cache, device configuration, or any other problem that could cause a data integrity exposure. | | | |
| Format Required | The disk unit must be formatted to become usable on this IOA. | | | |

Related concepts

 $\underline{I/O}$ adapter states There are three possible states for the I/O adapter.

Disk array states A disk array can be in one of seven states.

I/O adapter states

There are three possible states for the I/O adapter.

The three possible states for I/O adapters are described in the following table:

| Table 6. I/O adapter states | | | | |
|--|--|--|--|--|
| State Description | | | | |
| Operational The IOA is functional. | | | | |
| Not Operational The device driver cannot successfully communicate with this IOA. | | | | |

| Table 6. I/O adapter states (continued) | | | | |
|--|-------------|--|--|--|
| State | Description | | | |
| Not Ready The IOA requires a microcode download. | | | | |

Related concepts

Disk array states

A disk array can be in one of seven states.

Physical disk states

There are six possible states for the physical disks.

RAID controller software

A device driver and a set of utilities must be installed so that the controller can be identified and configured by the Linux operating system.

Note: References to the Linux operating system in this topic collection include the versions Linux 2.6, SUSE Linux Enterprise Server 10 and SUSE Linux Enterprise Server 11, Red Hat Enterprise Linux 4, Red Hat Enterprise Linux 5, and Red Hat Enterprise Linux 6. Make sure you are consulting the appropriate section of this set of information for the operating system you are using.

This document might describe hardware features and functions. While the hardware supports them, the realization of these features and functions depends upon support from the operating system. The Linux operating system provides this support. If you are using another operating system, consult the appropriate documentation for that operating system regarding support for those features and functions.

For the controller to be identified and configured by the Linux operating system, the requisite device support software must be installed. Software for the controller consists of a device driver and a set of utilities.

The device driver is usually compiled as a kernel module named ipr.ko. The user utilities are usually packaged in a Red Hat Package Manager (RPM) called iprutils. The requisite software for the controller is often preinstalled as part of the normal Linux installation.

If the software package is not installed, software verification will fail. The missing packages can be installed from your Linux operating system CD-ROM. If you are missing components or need newer versions, obtain them from your Linux distributor or online at SourceForge.net.

The controller executes onboard microcode. The iprconfig utility in iprutils RPM can be used to update the microcode being used by the controller. For more information regarding the iprconfig utility, see "Updating the controller microcode" on page 55.

Verifying installation of the controller software

Verify that the ipr device driver for the controller is installed.

Before you begin

Consult the following table for the minimum ipr device driver version required for each supported adapter:

| Table 7. Minimum ipr device driver support | | | | | | |
|---|---------------------------------|--|---------------------------------|--|---------------------------------|-----------------|
| Supported Minimum supported main adapter line Linux version | | Minimum supported Red Hat Enterprise Linux version | | Minimum supported SUSE Enterprise Linux version | | |
| Custom card identificatio n number (CCIN) | Device driver ipr version | Kernel version | Device driver ipr version | RHEL Version | Device driver ipr version | SLES Version |

| Table 7. Minimum ipr device driver support (continued) | | | | | | | |
|--|--|--------|--|----------------------|--|------------|--|
| Supported adapter | ported Minimum supported main oter line Linux version | | Minimum supported Red Hat Enterprise Linux version | | Minimum supported SUSE Enterprise Linux version | | |
| 57B3 | 2.4.1 | 2.6.22 | 2.0.11.6 2.2.0.2 | RHEL4 U7 RHEL5 U2 | 2.2.0.2 | SLES10 SP2 | |
| 57B4 | 2.6.0 | 3.0 | 2.5.4 | RHEL6 U4 | 2.6.0 | SLES11 SP3 | |
| 57CE | 2.6.0 | 3.0 | 2.5.4 | RHEL6 U4 | 2.6.0 | SLES11 SP3 | |
| 57D7 | 2.6.0 | 3.0 | 2.6.0 | RHEL6 U5 | 2.6.0 | SLES11 SP3 | |
| 57D8 | 2.6.0 | 3.0 | 2.6.0 | RHEL6 U5 | 2.6.0 | SLES11 SP3 | |
| 57DC | 2.6.0 | 3.0 | 2.6.0 | RHEL6 U5 | 2.6.0 | SLES11 SP3 | |

Consult the following table for the minimum version of the iprconfig utility required for each supported function:

| Table 8. Versions of the iprconfig utility needed for SAS functions | | | | |
|---|----------------------------------|--|--|--|
| SAS function | Version of the iprconfig utility | | | |
| Base SAS support | 2.0.15.8 | | | |
| Displaying SAS drive path status | 2.2.5 | | | |
| High availability dual adapter support | 2.2.8 | | | |
| Migrating RAID array between RAID level 0 and 10 | 2.2.10 | | | |
| Change asymmetric access mode | 2.2.11 | | | |
| The latest version | 2.4.1 | | | |

About this task

You can verify several parameters of the device driver software.

Procedure

1. To verify that the ipr device driver for the controller is installed, type modinfo ipr | grep version.

Data is displayed in this form:

version: 2.6.0 srcversion: D720FC6935DA2B2638B177A

2. To verify the ipr device driver version, type # modinfo -F version ipr. You will see data in this form:

2.6.0

3. To verify that the iprconfig utility is installed, type iprconfig -version.

Output from this command will indicate if the utility is installed, and if so, version information will be displayed.

You will see data in this form:

iprconfig: 2.4.0 (Feb 07, 2014)

Linux ipr device driver updates

The controller device driver for the Linux operating system, ipr, is part of the Linux kernel. Linux distributors periodically release updated device drivers for their Linux kernels.

Updated device drivers are usually packaged in an RPM. The updated device drivers provided by the Linux distributors are well-tested with other parts of the Linux distribution. Contact your Linux distributor for detailed information about the procedure for obtaining and updating the ipr device driver.

The Linux device drivers provided by your Linux distribution might be a few versions behind due to their test and release cycles. The most up-to-date ipr device driver can be found in the main line Linux kernel tree. Main line Linux kernel trees can be downloaded from Linux Kernel Archives.

The ipr device driver is located in the drivers/scsi/ directory. Users can obtain the ipr device driver from a Linux kernel source tree and follow the instructions in Documentation/kbuild/modules.txt in the Linux kernel source tree to recompile the ipr device driver.



Attention:

- The ipr device driver depends on other parts of Linux kernel to work properly. Updating ipr device driver without updating other parts of Linux kernel might cause compiling errors or runtime errors and result in system crash and data loss. Only experienced users should update the ipr device driver from source code.
- A device driver is considered part of the Linux kernel. Updating a device driver may void a Linux service contract provided by your Linux distributor or service provider. Check your Linux distributor or service provider for their device driver update policy.

Updating the iprutils package

You can update the iprutils package.

Before you begin

You can update the iprutils package using the following methods:

• Downloaded the latest prebuilt iprutils rpms from http://www14.software.ibm.com/support/customercare/sas/f/lopdiags/home.html.

By clicking on the **Learn more and download tools**, you can access the **IBM POWER**[®] **Linux Tools Repository** website. The tools repository supports the RHEL6, RHLE7, SLES11, and SLES12. Follow the instructions on the website to download the latest iprutils rpm packages.

- Download the user space package iprutils from <u>Open Build Service</u>. Click **Download Package** and select the required GNU or Linux distribution. Follow the instructions on the page to set up the OBS repository and download the package.
- Download the user space package source code from <u>Open Build Service</u>. You can build iprutils from the source using **tar.gz** provided by the OBS. Download the source code from OBS by clicking the **Download** link for the latest version of iprutils in the **Actions** column. Unpack the source code and follow the build and install instructions provided in the README file.

You must install certain development headers and libraries before compiling iprutils:

| Table 9. Required development headers and libraries | | | | |
|--|---|--|--|--|
| RHEL4, RHEL5, and RHEL6 | SLES10 and SLES11 | | | |
| glibc-headers kernel-headers ncurses-devel pciutils-devel libsysfs-devel | glibc-devel ncurses-devel pci-utils-devel sysfsutils | | | |

About this task

When building iprutils in an RPM package, use the correct <RPM_DIR> for your system. If your system is running RHEL6 or RHEL7, use \$HOME/rpmbuild. If your system is running SLES11 or SLES12, use /usr/src/packages.

Procedure

- 1. Log on to the GNU or Linux system.
- 2. Enter rpmbuild -rebuild -target=ppc iprutils-x.y.z-1.src.rpm where *x.y.z* is the iprutils version to build the iprutils package.
- 3. Enter cd <RPM_DIR>/RPMS/ppc.
- 4. Enter rpm -U iprutils-x.y.z-1.*ppc*.rpm to update iprutils.

Common IBM SAS RAID controller tasks

The instructions in this set of topics pertain to the various tasks that can be performed to manage disk arrays. The interface for working with the IBM SAS RAID controller is iprconfig.

When managing the IBM SAS RAID controller, you work with the iprconfig interface.

Starting the iprconfig utility

Use the iprconfig utility to work with the RAID controller.

About this task

When you start the iprconfig utility, you can select from various tasks.

Procedure

To start the iprconfig utility, type the command iprconfig.

A menu offers options for working with your controller:

```
      IBM Power RAID Configuration Utility

      Select one of the following:

      1. Display hardware status

      2. Work with disk arrays

      3. Work with disk unit recovery

      4. Work with SCSI bus configuration

      5. Work with driver configuration

      6. Work with disk configuration

      7. Work with adapter configuration

      8. Download microcode

      9. Analyze log

      Selection:

      e=Exit
```

Status of devices, arrays, and paths

You can check on the status of your devices, arrays, and paths.

Use the methods described here to check the status of your devices, arrays, and paths.

Viewing device status

View the status of all devices controlled by the ipr device driver.

About this task

With this procedure you can view information about the disks and disk arrays on your system.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select the **Display Hardware Status** option.

The output displayed will be similar to the following example:

| + | Display Hardware Status | | | | | | |
|------------------------------------|--|--|---|--|--|--|--|
| Type 1: | Type option, press Enter. 1=Display hardware resource information details | | | | | | |
| OPT | Name | PCI/SCSI Location | Description | Status | | | |
| | sda sdb | 0000:00:01.0/0: 0000:00:01.0/0:4:2:0 0000:00:01.0/0:4:5:0 0000:00:01.0/0:4:10:0 0000:00:01.0/0:6:10:0 0000:00:01.0/0:8:0:0 00002:00:01.0/1: 0002:00:01.0/1:0 | PCI-X SAS RAID Adapter Physical Disk Physical Disk Enclosure Enclosure PCI-X SAS RAID Adapter Physical Disk | Operational Active Active Active Active Active Active Operational Active | | | |
| | sde | 0002:00:01.0/1:0:2:0 0002:00:01.0/1:0:4:0 0002:00:01.0/1:0:5:0 0002:00:01.0/1:0:6:0 0002:00:01.0/1:0:7:0 0002:00:01.0/1:255:0:0 | Physical Disk Advanced Function Disk Advanced Function Disk Advanced Function Disk Hot Spare RAID 0 Disk Array | Active Active Active Active Active Active Active | | | |
| | sdf | 0002:00:01.0/1:0:0:0 0002:00:01.0/1:255:1:0 0002:00:01.0/1:0:10:0 0002:00:01.0/1:0:11:0 0002:00:01.0/1:0:8:0 0002:00:01.0/1:0:9:0 0002:00:01.0/1:0:24:0 0002:00:01.0/1:2:24:0 | RAID 0 Array Member RAID 6 Disk Array RAID 6 Array Member RAID 6 Array Member RAID 6 Array Member RAID 6 Array Member Enclosure | Active Active Active Active Active Active Active Active Active | | | |
| e=E: | xit c | =Cancel r=Refresh t=Tog | ggle | | | | |

The five columns of the Display Hardware Status screen have the following meanings:

- The first column is an input field used to select a device to display additional information.
- The second column of output is the device's resource name.
- The third column of output is the device's PCI/SCSI location code. The format of this field is PCI Location/SCSI Host:SCSI Bus:SCSI Target:SCSI Lun.
- The fourth column of output is the device's description. Type t to toggle this field to be the device's Vendor/Product ID.
- The fifth column of output is the device's hardware status. For an overview of the possible disk, disk array and I/O adapter hardware statuses, see "Disk array overview" on page 22.
- 3. To view information on a specific device, select the desired device with a 1 and press Enter.

If multiple pages of information are available, you can press \pm to page down (forward) or b to page up (backward).

Results

When you view information on a specific device, the result will depend on which device you select. Information is presented similar to the following:

 Disk Unit Hardware Resource Information Details

 Disk Unit Hardware Resource Information Details
 Manufacturer
 IBM
 Product ID
 ST373455SS
 Firmware Version
 State
Physical location PCI Address. 0000:00:01.0 |SCSI Host Number 0 SCSI Channel 4 2 SCSI Lun : 0 Extended Details |EC Level D76038 |Part Number. 10N7200
 Device Specific (Z0)
 ...
 ...
 ...
 000005229F001002

 Device Specific (Z1)
 ...
 ...
 ...
 0402E005
 Device Specific (Z2) 0021 Device Specific (Z3) 07082 Device Specific (Z4) More... Press Enter to Continue e=Exit q=Cancel f=PageDn b=PageUp

The previous screen shows an overview of a particular piece of hardware on your system. Multiple pages of information might be available. Press f to page down (forward) or b to page up (backward).

Viewing array status

You can view the status of the disk array by using the procedure presented here.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Display disk array status.

You will see a screen similar to the following example:

```
Display Disk Array Status

Type option, press Enter.

1=Display hardware resource information details

OPT Name PCI/SCSI Location Description Status

0002:00:01.0/1:0:7:0 Hot Spare Active

sde 0002:00:01.0/1:255:0:0 RAID 0 Disk Array Active

0002:00:01.0/1:255:1:0 RAID 0 Disk Array Active

sdf 0002:00:01.0/1:255:1:0 RAID 6 Disk Array Active

0002:00:01.0/1:0:10:0 RAID 6 Array Member Active

0002:00:01.0/1:0:11:0 RAID 6 Array Member Active

0002:00:01.0/1:0:11:0 RAID 6 Array Member Active

0002:00:01.0/1:0:11:0 RAID 6 Array Member Active

0002:00:01.0/1:0:9:0 RAID 6 Array Member Active
```

Viewing path status

Use the iprconfig utility to view the SAS path status.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Display SAS path status.

The **Display SAS Path Status** screen that is displayed is similar to the following example:

```
Display SAS Path Status
```

| Type opt | Type option, press Enter. | | | | | |
|----------|------------------------------------|----------------------|---------------|-----------------|--|--|
| 1=Disp | 1=Display SAS Path routing details | | | | | |
| OPT Name | PCI/SCSI Lo | cation | Description | Status | | |
| sda | 0000:c0:01. | 0/0:0:2:0 | Physical Disk | Redundant Paths | | |
| sdb | 0000:c0:01. | 0/0:0:3:0 | Physical Disk | Redundant Paths | | |
| sdc | 0000:c0:01. | 0/0:0:4:0 | Physical Disk | Redundant Paths | | |
| e=Exit | q=Cancel r= | Refresh [.] | t=Toggle | | | |

4. To view information on a specific device, select the desired device with a 1 and press Enter. Output similar to the following is displayed:

| + | Display SAS Pa | ath Deta | ails | |
|--|--|----------------------|--|---|
| Device Location | | : /dev/s : 0000:0 | sda c0:01.0/0:0:2:0 | |
| SAS Port/SAS Address | Description | Active | Status | Info |
| 0/ 0/5005076C03023F01 0/5005076C0400C703 2/5005076C0400C703 0/5000CCA00376F4AC 2/5005076C03023F03 0/5005076C03023F03 0/5005076C0400C783 2/5005076C0400C783 1/5000CCA003B6F4AC 2/5000CCA00336F4AC | Physical Path IOA port Expander port Expander port Device port Device LUN Physical Path IOA port Expander port Expander port Device port Device LUN | No Yes | Healthy Functional Functional Functional Functional Healthy Functional Functional Functional Functional Functional Functional | 3.0Gbps 3.0Gbps 3.0Gbps Enabled 3.0Gbps 3.0Gbps 3.0Gbps 3.0Gbps 3.0Gbps B.0Gbps B.0Gbps |
| e=Exit q=Cancel | | | | |

RAID and JBOD formats

Disks must be formatted before they can be used and recognized in a disk array.

Before a disk can be used in an IBM SAS RAID disk array, it must be formatted for advanced function. Before a disk is recognized as a standalone disk, it must be formatted to JBOD. Procedures for performing these actions are contained in this set of information.

Formatting to advanced function

Before a disk can be used in a disk array or as a hot spare disk, it must be formatted for advanced function. Advanced function disks are physical disks that are formatted to a block size that is compatible with SAS RAID. The RAID block size is larger than a JBOD block size due to the SCSI T10 standardized data integrity fields along with logically bad block checking stored on each block with the data. The SAS RAID adapters support disk blocks based on 512 Bytes of data or 4K Bytes of data. The RAID block size for the 512 disks is 528 Bytes per sector and the RAID block size for the 4K disks is 4224 bytes per sector.

About this task

The steps in this procedure result in a disk formatted for advanced function.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Format device for RAID function.
- 4. From the list of eligible disk units, choose the disks you want to format for advanced function and press Enter.



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 for advanced function. These disks will not show up on the list of choices. In some cases, errors may be logged in the /var/log/messages file. For more detailed information, view that log file.

5. To proceed with the format, type c to confirm. To return to the previous menu without formatting the disks, type q.

Notes:

- After the formatting is complete, the disks are ready for use in disk arrays. Resource names (such as /dev/sdb) might change when the system is rebooted. This could affect kernel command line entries and fstab entries. You might want to reboot the server now.
- This task requires rewriting data to the whole disk. The required time varies depending on the disk capacities. For large disks, it might take hours to complete.

Formatting to JBOD

Before a disk is recognized as a standalone disk, it must be formatted to JBOD.

About this task

The steps in this procedure result in a disk formatted for JBOD.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Format device for JBOD function.
- 4. From the list of eligible disk units, choose the disks you want to format to JBOD and press Enter.



Attention: Continuing with this option will format the disks. All data on the disks will be lost.

5. To proceed with the format, type c to confirm. To return to the previous menu without formatting the disks, type q.

Notes:

- After the formatting is complete, the disks are ready for use as stand-alone disks. Resource names (such as /dev/sdb) might change when the system is rebooted. This could affect kernel command line entries and **fstab** entries. You might want to reboot the server now.
- This task requires rewriting data to the whole disk. The required time varies depending on the disk capacities. For large disks, it might take hours to complete.

Note: Resource names (such as /dev/sdb) might change as a result of reformatting. This could affect kernel command line entries and **fstab** entries. You might want to reboot the server now.

Creating and deleting disk arrays

Create and delete IBM SAS RAID disk arrays by following the procedures in this information set.

Follow the instructions provided in this section to create and delete IBM SAS RAID disk arrays.

Creating an IBM SAS RAID disk array

A disk array is created using a set of disks that are formatted for advanced function.

About this task

For disk arrays with data redundancy (RAID 5, 6, 10, 5T2, 6T2, and 10T2), if all of the disks are in the Zeroed state, the array becomes immediately protected against failures. However, if one or more of the disks 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 disks are placed in a Zeroed state by selecting Create an Array Candidate pdisk and format to RAID block size

before creating a disk array to fully initialize the disks and provide the shortest time to create the disk array.

A RAID array must be entirely composed of devices from the same device class. Multiple disk arrays, consisting of different device classes, may coexist on the same controller. The following are the supported device classes:

- 528 HDDs (10K or 15K)
- 4K HDDs (10K or 15K)
- 4K Nearline HDDs
- 528 SSDs
- 4K SSDs
- 528 Read Intensive (Mainstream) SSDs
- 4K Read Intensive (Mainstream) SSDs

Complete the following steps to create an IBM SAS RAID disk array:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Create a disk array.
- 4. Select the controller under which you would like to create a disk array, and then press Enter.
- 5. Select the disk units to be included in the disk array, and then press Enter.

If the disks do not have a status of Zeroed, first format them using the instructions provided at Formatting to advanced function. Formatting the disks reduces the overall RAID creation time and ensures the RAID array is fully optimized following RAID creation. The information that you see will be similar to the following screen:

6. Select the protection level that you want for the array.

For more information about selecting an appropriate RAID level, see <u>"Supported RAID levels" on page</u> <u>14</u>.

7. Select the stripe size that you want, in kilobytes, for the array.

For more information about selecting an appropriate stripe size, see "Stripe-unit size" on page 22.

8. Press Enter to continue.



Attention: All data on the selected drives will be lost when the disk array is created. If you are sure you want to create the disk array, press Enter. If you do not want to create the disk array, type q to cancel.

If you choose to create the disk array, a status screen is displayed until the operation is completed. If you want to create additional disk arrays, you can exit the status screen by typing e.

Results

When a disk array has been built, it is available to the Linux operating system like any SCSI disk. To find the resource name that has been assigned to the disk array, see the **Display Disk Array Status** screen.

Note: Resource names (such as /dev/sdb) might change as a result of creating a new disk array. This could affect kernel command line entries and fstab entries. You might want to reboot the server now.

Deleting an IBM SAS RAID disk array

Delete a disk array carefully to avoid losing data.

Before you begin

To preserve the data on the disk array, you must first back up all data that you want to save.

About this task



Attention: After a disk array is deleted, it cannot be accessed. All data will be lost and cannot be recovered.

A disk array cannot be deleted if it is currently being rebuilt or synched. However, it is possible to delete a disk array that is currently in use. Make sure the disk array is not being used before deleting it.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select **Delete a disk array**.

4. From the listed disk arrays, select the one you want to delete, and then press Enter.



Attention: All data on the selected drives will be lost when the disk array is deleted. If you are sure you want to delete the disk array, press Enter. If you do not want to delete the disk array, type q to cancel.

Remember: Resource names (such as /dev/sdb) might change when the system is rebooted. This could affect kernel command line entries and fstab entries.

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.

About this task

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 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, complete the following steps:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.

- 3. Select Migrate disk array protection.
- 4. Select the disk array to which you want to migrate the disk array protection level.
- 5. Press c and use up arrow and down arrow keys to change the protection level, and press Enter.

A screen will display similar to the following:

```
Select Protection Level

Current RAID protection level is shown. To change

setting hit "c" for options menu. Highlight desired

option then hit Enter

c=Change Setting

/dev/sdf - Protection Level . . . . . : RAID 0

Press Enter to Continue

e=Exit q=Cancel
```

6. Optional: If more member disks are required, for example when migrating from RAID 0 to 10, move the cursor by using the up arrow and down arrow keys at the list of candidate disks, and press 1 to select the desired disks. When you have completed your disk selection, press Enter.

A screen will display similar to the following example:

```
      Select Disk Units for Migration

      A minimum of 2 disks must be selected.

      A maximum of 2 disks must be selected.

      The number of disks selected must be a multiple of 2.

      OPT Name
      PCI/SCSI Location

      Vendor
      Product ID

      Status

      1
      sg12

      0003:00:01.0/2:0:2:0
      IBM

      HUS151473VLS300
      Active

      1
      sg13

      0003:00:01.0/2:0:3:0
      IBM

      HUS151473VLS300
      Active

      I = Exit
      q=Cancel
```

- 7. Optional: If fewer member disks are needed, for example when migrating from RAID 10 to RAID 0, the adapter will select the extra disks and take them out of the disk array automatically. No user intervention is needed.
- 8. Press Enter to confirm the RAID migration.

The migration between different RAID levels takes anywhere from several seconds to several hours. A progress screen displays the migration progress. Migration progress can also be found in the **Display Disk Array Status** screen and **Display Hardware Status** screen.

Hot-spare disks

Use hot-spare disks to automatically replace failed disks in a RAID environment.

Upon a disk failure in a RAID array is detected, the RAID adapter will look into all disks it controls for a hot-spare disk. If one is available, the RAID adapter will replace the role of the failed disk in the RAID array with the hot-spare disk. The data and parity are rebuilt from the survival member disks automatically. The RAID array is changed back to optimized state when the rebuild is complete.

It is important to note that a hot-spare disk will only replace a disk in an the array tier of the same device class as the hot spare. Therefore, you need different hot-spare disks available to fully cover all array device classes under the adapter. tiers in a tiered RAID level. For example, a 4K SSD hot spare is needed for an array composed of 4K SSDs and a 4K HDD hot spare is needed for an array composed of 4K HDDs.

A RAID array must be entirely composed of devices from one of the following device classes:

- 528 HDDs (10K or 15K)
- 4K HDDs (10K or 15K)

- 4K Nearline HDDs
- 528 SSDs
- 4K SSDs
- 528 Read Intensive (Mainstream) SSDs
- 4K Read Intensive (Mainstream) SSDs

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. To assign a disk for use as a hot spare, it must be formatted for advanced function.

For disk arrays with Easy Tier function, it is important to note that a hot-spare disk will only replace a disk in the tier that has the similar performance characteristics as the hot spare. So, you need different hotspare disks to fully cover all tiers in a tiered RAID level. For example, an SSD hot spare and a HDD hot spare.

Creating hot-spare disks

Create a hot-spare disk to automatically replace a failed disk in a RAID environment.

Before you begin

Formata disk for advanced function if you want to use it as a hot spare disk.

About this task

Complete the following steps to create hot-spare disks:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Create a hot spare.
- 4. Select the adapter for which you want to create hot spares and press Enter.
- 5. Select the disks that you want to designate as hot spares and press Enter.



Attention: All data on the selected drives will be lost when the disks are configured as hot spares.

6. To configure the disks as hot spares, press Enter. If you do not want to configure the disks as hot spares, type q to cancel.

Related tasks

Formatting to advanced function

Before a disk can be used in a disk array or as a hot spare disk, it must be formatted for advanced function. Advanced function disks are physical disks that are formatted to a block size that is compatible with SAS RAID. The RAID block size is larger than a JBOD block size due to the SCSI T10 standardized data integrity fields along with logically bad block checking stored on each block with the data. The SAS RAID adapters support disk blocks based on 512 Bytes of data or 4K Bytes of data. The RAID block size for the 512 disks is 528 Bytes per sector and the RAID block size for the 4K disks is 4224 bytes per sector.

Deleting hot-spare disks

Delete a hot-spare disk to free it for use in other disk arrays.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk arrays.
- 3. Select Delete a hot-spare device.
- 4. Select the hot-spare disks to be deleted and press Enter.

5. To reconfigure the disks, press Enter. If you do not want to reconfigure the disks as hot spares, type q to cancel.

Drive queue depth

For performance reasons, you might want to change the queue depth of the disk command. The disk queue depth limits the maximum number of commands that the Linux software can issue concurrently to that disk at any time.

Increasing the disk queue depth might improve the disk performance by increasing disk throughput (or I/O) but might also increase latency (response delay). Decreasing the disk queue depth might improve disk response time but decrease the 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.

Viewing the drive queue depth

To view the current queue depth on any disk (JBOD or RAID), use the **iprconfig** -c **query-qdepth sda** command from the iprconfig utility command line. Alternatively, you can use iprconifg graphical interface (**iprconfig** > **Work with disk configuration**).

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 | |
|-------------------------------|--|
| Queue depth | PCIe3 adapters |
| Default JBOD disk queue depth | 16 |
| Default RAID disk queue depth | 16 times the number of disks in the RAID array |

Example

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

iprconfig -c query-qdepth sda

The system displays a message similar to the following: 16.

Changing the drive queue depth

You can change the drive queue depth from the command line by running the following command:

iprconfig -c set-qdepth sda 64

Linux command-line interface

You can perform tasks to manage the SAS RAID controllers by using the iprconfig utility command line instead of using the iprconfig graphical interface. The following table summarizes the commonly used command-line interface commands. For the full list of command line options, see the iprconfig man page.

| Table 11. iprconfig utility commands | |
|--------------------------------------|--|
| Task | Command |
| General help | man iprconfig |
| Viewing the disk array status | iprconifg -c show-arrays |
| Format device for advanced function | iprconfig -c format-for-raid [disk][disk] |
| Format device for JBOD function | iprconfig -c format-for-jbod [disk][disk] |

| Table 11. iprconfig utility commands (continued) | | |
|--|--|--|
| Task | Command | |
| Creating a SAS disk array | iprconfig -c raid-create -r [raid- level] -s [strip_size] [devices] | |
| Deleting a SAS disk array | iprconfig -c raid-delete [RAID device] | |
| Adding disks to an existing disk array | iprconfig -c raid-include [array] [disk][disk] | |
| Creating hot-spare disks | iprconfig -c hot-spare-create [disk] | |
| Deleting hot-spare disks | <pre>iprconfig -c hot-spare-delete [disk]</pre> | |
| Displaying rechargeable battery information | iprconfig -c show-battery-info [IOA] | |

Considerations for solid-state drives (SSD)

The purpose of this section is to cover important controller functions when using solid-state drives (SSD).

Before you begin

Hard disk drives (HDD) use a spinning magnetic platter to store data in magnetic fields in nonvolatile storage. 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 latency and 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

While using SSDs, consider the following 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 properly 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 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, 10, 5T2, 6T2, or 10T2.
- Identify specific configuration and placement requirements related to the SSD devices.
- SSDs are supported only when formatted to a RAID block size and used as part of a RAID array.

A RAID array must be entirely composed of devices from one of the following device classes:

- 528 HDDs (10K and/or 15K)
- 4K HDDs (10K and/or 15K)
- 4K Nearline HDDs
- 528 SSDs
- 4K SSDs
- 528 Read Intensive (Mainstream) SSDs
- 4K Read Intensive (Mainsteam) SSDs

Adapter cache control

Adapter caching improves overall performance with disk drives. In some configurations, adapter caching might not improve performance when you use SSD disk arrays. In these situations, adapter caching can be disabled by using the Change Configuration of Adapter window.

About this task

To disable adapter caching, complete the following steps:

Procedure

- 1. Run the iprconfig utility by typing **iprconfig**.
- 2. Select Work with adapter configuration.
- 3. Select the desired adapter by typing 1, and press Enter.
- 4. Select IOA Caching Mode.
- 5. Type **c**.
- 6. Select **Disabled** and press Enter.

A display similar to the following example appears in the window.

Example

Change configuration of Adapter Current Adapter configurations are shown. To change setting hit 'c' for options menu. Highlight desired option then hit Enter. c=Change Setting Adapter: 0001:00:01.0/33 IBM 574E001SISIOA Preferred Dual Adapter State : Primary Active/Active Mode : Default IOA Caching Mode : Default Or leave blank and press Enter to cancel e=exit q=cancel

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) in the SAS arena refer to connecting multiple controllers (typically two controllers) to a common set of disk expansion drawers for the purpose of increasing availability. IBM SAS RAID controllers support high availability with up to two controllers in one or two systems.

IBM SAS RAID controllers support 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 high availability cluster applications such as the IBM PowerHA[®] SystemMirror[®]. The IBM HACMP 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 RAID format. 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 JBOD format. This JBOD alternative is supported only on particular controllers and requires unique setup and cabling.

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 Multi-Path I/O (MPIO). MPIO

support in the Linux operating system is provided by Device-Mapper Multipath 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 RAID format and used in one or more disk array. Any RAID level, or combination of RAID levels, may be used. Disks formatted to JBOD format are not supported in an HA single-system configuration.

Disks formatted to 512 bytes per sector are allowed in an HA single-system configuration. These disks are detected through both SAS controllers with two different paths and assigned with two different /dev/sdX names, for example, /dev/sde and /dev/sdf. The disks can be accessed using either path. However, there is no additional coordination between the two SAS controllers to automatically switch between the two paths. Multipath IO software such as Device-Mapper Multipath needs to be configured to monitor and switch paths. Using Device-Mapper Multipath to provide HA function is a software-only solution that is independent of IBM SAS RAID controllers. Its use is beyond the scope of this document.

Not all controllers support all configurations. Refer to the comparison tables and look for controllers that have the entry **Yes** for **HA two-system RAID**, **HA two-system JBOD**, or **HA single-system RAID**.

Possible HA configurations

Compare RAID features as used with single- and two-system HA configurations.

| Table 12. SAS RAID HA configurations | | | |
|--|---|---|--|
| Multi-initiator configuration | HA two system (for example PowerHA for AIX®) | HA single system (for example MPIO) | |
| RAID (disks formatted RAID block size per sector) | Maximum of two controllers Both controllers must have same write cache capability and write cache sizes Both controllers must support | 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 | "HA single-system RAID"Controllers are in the same system or partition | |

The following figures illustrate an example of each configuration.

HA Two System RAID



P9EBJ006-0

HA Single System RAID



Controller functions

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

Use of the multi-initiator and HA functions require controller and Linux software support. Controller support is shown in the <u>"Feature comparison of SAS RAID cards" on page 2</u> table. 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 Linux software levels required for multi-initiator support are identified in Versions of iprconfig for SAS functions.

Specific controllers are intended only to be used in either an HA two-system RAID or HA single-system RAID configuration. Use the <u>"Feature comparison of SAS RAID cards" on page 2</u> table to look for controllers that have Requires HA RAID configuration marked as Yes. This type of controller may not 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 reconfiguring a controller previously configured in a different HA configuration, it is recommended to configure the High-Availability Mode of the controllers to RAID or JBOD before attaching the SAS cables.

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

Note: On two-system configurations, the usage of the disk array may need to be discontinued from the secondary controller before some actions can be performed from the primary controller.

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 to the disk arrays for purposes of read and write operations, but at any given time only one controller in the pair is "optimized" for the disk array. The controller that is optimized for a disk array is the one that directly accesses the physical devices for I/O operations. The controller that is non-optimized for a disk array will forward read and write requests through the SAS fabric to the optimized controller. See <u>"HA asymmetric access optimization" on page 47</u> for more information on setting and viewing disk array optimization.

The primary controller logs most errors related to problems with a disk array. Some disk array errors may also be logged on the secondary if a disk array is optimized on the secondary, 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. Such a transition is because the controller would reset itself to activate the new microcode. The controller will be temporarily offline until the reset is complete. Failover to another controller can prevent disk access disruption.

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).

Controller function attributes

Compare important attributes of controller functions.

| Table 13. SAS controller functions | | |
|--|----------------------------------|-------------------------------------|
| Controller functions | HA two-system RAID configuration | HA single-system RAID configuration |
| JBOD block size disks supported | No ¹ | No ¹ |
| RAID block size disks supported | Yes | Yes |
| Mirrored write cache between controllers (for controllers that have write cache) | Yes | Yes |

r

| Table 13. SAS controller functions (continued) | | | |
|--|--|--|--|
| Controller functions | HA two-system RAID configuration | HA single-system RAID configuration | |
| Mirrored RAID parity footprints between controllers | Yes | Yes | |
| Dual paths to disks | Yes | Yes | |
| Target mode initiator device support | Yes | No | |
| Only IBM qualified disk drives supported | Yes | Yes | |
| Only IBM qualified disk expansion drawer supported | Yes | Yes | |
| Tape or optical devices supported | No | No | |
| Boot support | No | Yes | |
| Operating mode ² | Primary Adapter or Secondary Adapter ³ | Primary Adapter or Secondary Adapter ³ | |
| Preferred Dual Initiator Operating mode ² | None (no preference) or Primary ³ | None (no preference) or Primary ³ | |
| Dual Initiator Configuration ² | Default ³ | Default ³ | |
| High-Availability Mode | RAID ³ | RAID ³ | |
| Manage HA Access Characteristics ⁴ | Yes | Yes | |

1. JBOD block size (512 or 4096 bytes per sector) disks are not to be used functionally, but will be available to be formatted to RAID block size (528 or 4224 bytes per sector.)

- 2. Can be viewed by using the Change Adapter Configuration screen.
- 3. This option can be set by using the Change Adapter Configuration screen.
- 4. For information on managing the HA asymmetric access state for a disk array, see <u>"HA asymmetric access optimization" on page 47</u>.

Viewing HA controller attributes

You can view HA configuration-related information from the **Change Adapter Configuration** menu located under the iprconfig menu option titled **Work with adapter configuration**.

Procedure

- 1. Run iprconfig.
- 2. Type 7 to select Work with adapter configuration.
- 3. Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then, press Enter.
- 4. In the menu option titled Change Configuration of Adapter:
 - a) Configure Preferred Dual Adapter State to None or Primary.
 - b) Configure High-Availability Mode to RAID or JBOD.

The screen displayed will look similar to the following example.

Change Configuration of Adapter Change Configuration of Adapter Current Disk configurations are shown. To change setting hit 'c' for options menu. Highlight desired option then hit Enter. c=Change Setting

| Adapter: 0000:c8:01.0/0 IBM 572A001SISIOA | |
|---|---|
| Preferred Dual Adapter State : None High-Availability Mode : Normal | |
| Active/Active Mode Disabled | |
| Or leave blank and press Enter to cancel | |
| e=Exit q=Cancel | |
| + | + |

Note: For additional details on how to set up a configuration, see <u>"Installing an HA single-system RAID</u> configuration" on page 50 or <u>"Installing an HA two-system RAID</u> configuration" on page 52.

High availability cabling considerations

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

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's better SAS fabric redundancy for RAID configurations versus JBOD configurations.

To see examples of how to cable HA configurations, see Planning for serial-attached SCSI cables.

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

HA performance considerations

Controller failures can impact performance.

The controller is designed to minimize performance impacts when running in an HA configuration. When using RAID 5, 6, 10, 5T2, 6T2, and 10T2 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, 6, 5T2, and 6T2.

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 (that performs direct management of the physical devices) and the secondary controller (that 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.



Attention: Attempting these commands on a secondary controller might return unexpected results.

The following tasks are the common iprconfig tasks that must be performed from the primary controller:

- Under the iprconfig menu option titled Work with disk arrays:
 - Create a disk array
 - Delete a disk array

Note: On two-system configurations, the usage of the disk array may need to be discontinued from the secondary controller before some actions can be performed from the primary controller such as deleting the array.

- Add a device to a disk array

- Format device for RAID function
- Format device for JBOD function
- Work with hot spares
- Work with asymmetric access
- 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
 - Rebuild disk unit data
 - Force RAID Consistency Check
- Under the iprconfig menu option titled Work with disk configuration:
 - Change Queue Depth
 - Change Format Timeout
- Under the iprconfig menu option titled **Download microcode**:
 - Adapter microcode download
 - Disk microcode download
 - SES device microcode download

HA asymmetric access optimization

HA access characteristics can balance the controller workload.

Important: Update each controller to the latest SAS controller microcode from the code download website. For instructions, see <u>"Updating the controller microcode" on page 55</u>. This update must be performed to obtain the latest critical fixes to ensure proper functioning.

By default, the primary adapter is optimized for all RAID arrays. The secondary adapter is non-optimized for all RAID arrays. The workload is not balanced between the two controllers. With either of the HA RAID configurations, maximum performance might be achieved by defining HA asymmetric access state for each disk array such that the workload is balanced between the two controllers. Setting the HA asymmetric access state for a disk array specifies which controller is preferred to be optimized for the disk array and perform direct reads and writes to the physical devices.

HA Access Optimization

The example assumes this setup: RAID Array "A" Optimized on Primary RAID Array "B" Optimized on Secondary



Figure 18. HA access optimization

Once the HA asymmetric access is enabled, HA asymmetric access states are displayed on the **Array Asymmetric Access** screen under the menu option titled **Work with Disk Arrays**, similar to the following screen; note that the status column shows the primary adapter view of the HA asymmetric access states of RAID arrays in HA single system RAID configuration:

| + | | + |
|--|----------------------------------|---|
| Array Asymmetric Access | | ļ |
| Select the disk array path. Type choice, press Enter. 1=change asymmetric access for a disk array OPT Name PCI/SCSI Location Description | Status | |
| sdd 0002:00:01.0/1:255:0:0 RAID 5 Disk Array sde 0002:00:01.0/1:255:1:0 RAID 10 Disk Array sdh 0002:00:01.0/1:255:2:0 RAID 0 Disk Array e=Exit q=Cancel r=Refresh t=Toggle | Active Optimized Optimized | |

By using the up/down arrow keys to move the cursor to the desired RAID array, you can select it by pressing 1 followed by Enter. The HA asymmetric access state of the selected RAID array is displayed on the **Change Asymmetric Access Configuration of Array** screen, similar to the following:

```
Current array asymmetric access configuration is shown. To change setting hit

'c' for options menu. Highlight desired option then hit Enter.

c=Change Setting

Array: /dev/sdh

Current asymmetric access state: Optimized

Saved asymmetric access state: Not Set

Preferred Asymmetric Access State. . . : Not Set

Or leave blank and press Enter to cancel

le=Exit q=Cancel
```

This display shows the HA asymmetric access state for the disk arrays selected. For each disk array listed, the current and preferred HA asymmetric access states 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.

There are three possible access state settings used for the HA asymmetric access state:

Optimized

The selected controller performs direct access for this disk array. This gives I/O operations performed on selected controller optimized performance compared to the remote controller. The selected disk array will be set to Non-Optimized on the remote adapter.

Non-Optimized

The selected controller performs indirect access for this disk array. This gives I/O operations performed on selected controller non-optimized performance compared to the remote controller. The selected disk array will be set to Optimized on the remote adapter.

Not Set

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

The HA asymmetric access state can only be displayed and modified from the primary controller. The **Preferred Asymmetric Access** state can be modified when the disk array is selected from the primary controller. Changing the **Preferred Asymmetric Access** state from the primary controller stores the settings in the disk array and will automatically set the opposite settings on the secondary controller.

The controller will always try to switch the **Current Asymmetric Access** state of the disk array to match the **Preferred Asymmetric Access** state. This switching is done in the background by the controller; therefore, there may be delays between setting the **Preferred Asymmetric Access** state and seeing **Current Asymmetric Access** state switch. There are also situations where the controller will not switch HA asymmetric access state due to scenarios involving configuration errors, failed components, and certain RAID configuration activities.

By default all disk arrays are created with a **Preferred Asymmetric Access** state of Not Set. In order to maximize performance it is recommended that, when appropriate, multiple disk arrays be created and optimized equally between the controller pair. This is accomplished by setting the **Preferred Asymmetric Access** to Optimized for half of the disk arrays and Non-Optimized to the other half.

Enabling asymmetric access

HA asymmetric access, an advanced function, is not enabled by default. Use the procedure here to enable it.

About this task

Perform the following steps on both the primary and the secondary controllers to enable HA asymmetric access:

Procedure

- 1. Run the **iprconfig** command.
- 2. Type 7 to select **Work with adapter configuration**.
- 3. Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter.

4. In the menu option titled **Change Configuration of Adapter**, configure **Active/Active Mode** to **Enabled**.

Asymmetric access status of disk arrays

The current asymmetric access status of your disk arrays can be easily accessed.

The current asymmetric access states of your disk arrays are displayed in the Status column of the **Display Hardware Status** screen (located under the main menu of iprconfig) and **Display Disk Array Status** screen (located under the menu option titled **Work with disk arrays**). An array can be in an Optimized state or an Active (non-optimized) state; see "HA asymmetric access optimization" on page 47.

IBM SAS RAID controllers are in a pair in HA single- and two-system RAID configurations. A RAID array that is Active (non-optimized) on the primary adapter is Optimized on the secondary adapter, and vice versa. RAID arrays are optimized on one of the two IBM SAS RAID controllers unless an error is detected.

The status of array members can be used to determine if the RAID array is on the primary or secondary adapter. When an array member has a status of Active, it indicates the RAID array is on the primary adapter. When the status is Remote, it indicates the RAID array is on the secondary adapter.

In the sample **Display Disk Array Status** screen of the HA single-system configuration shown in the following screen, the RAID 5 array is shown as sdd and is Active (non-optimized) on the primary adapter, while on the secondary adapter it is shown as sdf and Optimized. The RAID 10 array is shown as sde and Optimized on the primary adapter, and sdg and Active (non-optimized) on the secondary adapter.

| + | Display | Disk Array Status | | | |
|--------------|--|--|---|--|--|
| Type op | Type option, press Enter. | | | | |
| 1=Dis | 1=Display hardware resource information details | | | | |
| OPT Nam | e PCI/SCSI Location | Description | Status | | |
| sdd | 0002:00:01.0/1:255:0:0 | RAID 5 Disk Array | Active | | |
| | 0002:00:01.0/1:0:1:0 | RAID 5 Array Member | Active | | |
| | 0002:00:01.0/1:0:2:0 | RAID 5 Array Member | Active | | |
| | 0002:00:01.0/1:0:3:0 | RAID 5 Array Member | Active | | |
| sde | 0002:00:01.0/1:255:1:0 0002:00:01.0/1:0:8:0 0002:00:01.0/1:0:9:0 | RAID 10 Disk Array RAID 10 Array Member RAID 10 Array Member | Optimized Active Active | | |
| sdh | 0002:00:01.0/1:255:2:0 | RAID 0 Disk Array | Optimized | | |
| | 0002:00:01.0/1:0:10:0 | RAID 0 Array Member | Active | | |
| | 0002:00:01.0/1:0:11:0 | RAID 0 Array Member | Active | | |
| sdf | 0003:00:01.0/2:255:0:0 0003:00:01.0/2:0:3:0 0003:00:01.0/2:0:1:0 0003:00:01.0/2:0:2:0 | RAID 5 Disk Array RAID 5 Array Member RAID 5 Array Member RAID 5 Array Member | Optimized Remote Remote Remote | | |
| sdg | 0003:00:01.0/2:255:1:0 | RAID 10 Disk Árray | Active | | |
| | 0003:00:01.0/2:0:9:0 | RAID 10 Array Member | Remote | | |
| | 0003:00:01.0/2:0:8:0 | RAID 10 Array Member | Remote | | |
| sdi | 0003:00:01.0/2:255:2:0 | RAID 0 Disk Array | Active | | |
| | 0003:00:01.0/2:0:10:0 | RAID 0 Array Member | Remote | | |
| | 0003:00:01.0/2:0:11:0 | RAID 0 Array Member | Remote | | |
| e=Exit | q=Cancel r=Refresh t=To | oggle | | | |

Installing high availability

Use the procedures in this section when performing HA installations.

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

Installing an HA single-system RAID configuration

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

Before you begin

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 <u>"Configuration and serviceability considerations for HA RAID configurations" on page 46</u> for important considerations.

Procedure

1. Install and update the iprutils package on each system or partition.

See "Updating the iprutils package" on page 28 for more information.

2. Power off the system or partition and install the SAS controllers into the system or partition.

If you do not want to power off the machine or partition, Linux hot plug can be used to install the SAS controllers without powering off the system or partition.



Attention: 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 website. See <u>"Updating the controller microcode</u>" on page 55.
- 4. To prevent errors while connecting the cables, configure the SAS controllers to the HA single-system RAID configuration before attaching any cables to the SAS controllers:
 - a) Run iprconfig.
 - b) Type 7 to select Work with adapter configuration.
 - c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.
 - d) In the menu option titled **Change Configuration of Adapter**, configure **Preferred Dual Adapter State** to None and **High-Availability Mode** to RAID.
- 5. Attach an X 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 Planning for serial-attached SCSI cables.

- 6. Power on the system or partition if it was powered off. Verify that the cabling and functioning of the controllers are correct by using the **Display Hardware Status** screen. Each SAS controller in dual-initiator configuration should show an optional block of Remote Adapter information for the other SAS controller.
 - a) Run iprconfig
 - b) Type 1 to select Display Hardware Status.
 - c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.

An optional block of Remote Adapter information for the other SAS controller in the remote system or partition is shown in the bottom of the **IOA Hardware Resource Information Details** screen, similar to the following example:

| IOA | Hardware Resource Information Details | + |
|--|---|---|
| Manufacturer Machine Type and Model Firmware Version Serial Number Part Number Plant of Manufacturer. Cache Size DRAM Size Resource Name | : IBM : 572B001SISIOA : 03200046 : 07125793 : 0000042R4591 : 0022 : 0EE MB : /dev/sg20 | |
| Physical location PCI Address SCSI Host Number Current Dual Adapter Sta Preferred Dual Adapter Sta Remote Adapter Manufactu | 0002:00:01.0 1 ate Primary State No Preference urer IBM | |

```
      Remote Adapter Machine Type And Model. . : 572B001SISIOA

      Remote Adapter Serial Number . . . . . : 07125687

      Current Asymmetric Access State. . . . . : Disabled

      Press Enter to Continue

      e=Exit q=Cancel
```

7. Optional: Configure one of the controllers in the HA single-system RAID configuration to be the Preferred Primary controller by following the steps below:

Note: Such configuration is often 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.

- a) Run iprconfig
- b) Type 7 to select Work with adapter configuration.
- c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.
- d) In the menu option titled **Change Configuration of Adapter**, configure **Preferred Dual Adapter State** to Primary.

When determining the Preferred Primary controller, consider the following:

- 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, is 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.

Installing an HA two-system RAID configuration

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

Before you begin

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 46 and "Functions requiring special attention in an HA two-system RAID configuration" on page 54 for important considerations.

Procedure

1. Install and update the iprutils package on each system or partition.

See "Updating the iprutils package" on page 28 for more information.

2. Power off the system or partition and install the SAS controllers into the system or partition.

If you do not want to power off the machine or partition, Linux hot plug can be used to install the SAS controllers without powering off the system or partition.



Attention: 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 website. See "Updating the controller microcode" on page 55.
- 4. To prevent errors while connecting the cables, configure the SAS controllers to the HA two-system RAID configuration before attaching any cables to the SAS controllers:

a) Run the iprconfig command.

- b) Type 7 to select Work with adapter configuration.
- c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.
- d) In the menu option titled **Change Configuration of Adapter**, configure **Preferred Dual Adapter State** to None and **High-Availability Mode** to RAID.
- 5. Attach an X 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 Planning for serial-attached SCSI cables.

- 6. Power on the system or partition if it was powered off. Verify that the cabling and functioning of the controllers are correct by using the **Display Hardware Status** screen. Each SAS controller in dual-initiator configuration should show an optional block of Remote Adapter information for the other SAS controller.
 - a) Run the iprconfig command.
 - b) Type 1 to select Display Hardware Status.
 - c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.

An optional block of Remote Adapter information for the other SAS controller in the remote system or partition is shown in the bottom of the **IOA Hardware Resource Information Details** screen, similar to the following example:

| + IOA Hardware Resource Information Details | + |
|--|--------|
| Manufacturer Imanufacturer Machine Type and Model 572B001SISI0A Firmware Version 93200046 Serial Number 97125687 Part Number 9000042R4591 Plant of Manufacturer 9022 Cache Size 175 MB DRAM Size 9E MB Resource Name 164v/sg26 | |
| Physical location PCI Address 0002:00:01.0 SCSI Host Number | |
| Preferred Dual Adapter State : No Preference Remote Adapter Manufacturer : IBM Remote Adapter Machine Type And Model : 572B001SISIOA Remote Adapter Serial Number : 07125793 | |
| Current Asymmetric Access State : Disabled | |
| Press Enter to Continue | İ |
| e=Exit q=Cancel + | + |

7. Optional: Configure one of the controllers in the HA two-system RAID configuration to be the Preferred Primary controller by following the steps below:

Note: Such configuration is often 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.

- a) Run the iprconfig command.
- b) Type 7 to select Work with adapter configuration.
- c) Use the up/down arrow keys to move the cursor to the SAS controller and type 1; then press Enter to select it.
- d) In the menu option titled **Change Configuration of Adapter**, configure **Preferred Dual Adapter State** to Primary.

When determining the Preferred Primary controller, consider the following:

- 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, is 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.

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 containing the primary controller. Any functions performed on the system or partition containing the primary controller might also require some manual intervention on the system or partition containing secondary controller to get visibility to the new configuration.

| Table 14. Configuration steps for the secondary controller | | | |
|---|--|--|--|
| Function performed on primary controller | Required configuration on secondary controller | | |
| Format device for advanced function | No configuration steps needed | | |
| Format device for JBOD function | No configuration steps needed | | |
| Create Disk Array | No configuration steps needed | | |
| Delete Disk Array ¹ | Issue the SCSI Stop Unit command to the array sg_start stop /dev/sdX | | |
| 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) | No configuration steps needed | | |
| Remove disk (Hot Plug Manager) | No configuration steps needed | | |
| Reclaim Controller Cache Storage | No configuration steps needed | | |
| ¹ The sg_start command is provided by the sg3_utils package. | | | |

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

IBM SAS RAID controller maintenance

Maintenance procedures include microcode updates, failure recovery procedures, and working with the battery pack.

Follow the recommended maintenance procedures in this section to help maintain your RAID controller for the Linux operating system.

Usage tips

Follow recommended usage tips to help avoid controller and disk array problems.

The following usage tips will help you maintain your controller.

• Always perform a normal system shutdown before physically replacing or moving the RAID adapter or members of disk arrays. A normal shutdown of the system will flush the adapter's write cache and remove dependencies between the adapter and the physical disks. Using the **modprobe -r ipr** command will have the same effect as a system shutdown. For systems that support PCI hot plug, PCI hot plug will also have the same effect as a system shutdown.

Note: A disk that is a failed member of a Degraded disk array can be replaced and the disk array rebuilt while the system continues to run.

- You can physically move disks from one adapter to another. However, if the physical disks are members of a disk array, be sure to move all the disks 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.
- When physically removing disks 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 these disks are used.
- Always use the "Concurrent device remove" screen to remove and replace a physical disk. For instructions on how to remove and replace a disk, see "Removing a failed disk" on page 56.
- 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 into Rescue mode. Linux error logs, the iprconfig utility, and other tools are available to help determine and resolve the problem with the disk array.
- Do not attempt to correct problems by swapping adapters and disks unless you are directed to do so by the service procedures. This is likely to make the problems worse. For additional information regarding problem determination, see <u>"Problem determination and recovery" on page 62</u>.
- If multiple errors occur at approximately the same time, look at them as a whole to determine if there might be a common cause.

Updating the controller microcode

Disk drives attached to this RAID adapter must contain the latest microcode level. Microcode can be updated using the iprconfig utility.

Before you begin

Download the latest microcode level for your drive model and controller from Fix Central. If you download new microcode from the website, follow the instructions in the readme file or Desc link on the website to install it. Use the installation procedure below only if there are no instructions available.

About this task

The iprconfig utility allows for multiple levels of adapter and device microcode to exist on the system at the same time. After the adapter or device to update microcode is selected, all available microcode levels are presented to choose to download.

Note: For either an auxiliary cache adapter or a storage I/O adapter which attaches to an auxiliary cache adapter, it is recommended that both the storage I/O adapter and auxiliary cache adapter be updated.

Procedure

- 1. Install the package by typing rpm -ivh pci.101402BD.20-01200041-1.Linux.noarch.rpm.
- 2. Update the microcode by typing iprconfig.
- 3. Select Work with microcode updates and press Enter.
- 4. Select **Download microcode** and press Enter.
- 5. Select the device or adapter you wish to update by typing a 1, and then press Enter. Multiple devices can be selected.
- 6. Select the microcode image to be downloaded to the device or adapter by typing a 1and then press Enter.
- 7. Press Enter again to confirm the download.
- 8. If multiple devices were selected, repeat from Step <u>"6" on page 55</u> for the next device.

Physical disks

Replace failed disks as soon as possible, even if a rebuild was initiated on a hot spare by the controller.

Use the **Concurrent remove device** option in the iprconfig utility to replace physical disks attached to the controller.

Removing a failed disk

Use the iprconfig utility to remove a failed disk.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Concurrent Device Remove.

The resulting screen is similar to the following example:

Concurrent Device Remove Choose a single location for remove operations 1=Select OPT Name Platform Location Description Status U5888.001.6BAH025-P1-D1 Advanced Function Disk sg1 Active U5888.001.6BAH025-P1-D2 Advanced Function Disk Active sg0 sg2 U5888.001.6BAH025-P1-D5 Advanced Function Disk Active U5888.001.6BAH025-P1-D6 Emptv U5888.001.6BAH025-P1-D7 Empty U5888.001.6BAH025-P1-F8 Empty e=Exit q=Cancel t=Toggle

- 4. Select the device to be removed by typing 1, and press Enter.
- 5. Verify that the selected device is the device to be removed. The Identify indicator should now be set. Press Enter.



Attention: iprconfig allows removal of devices that are currently being used by the system. Ensure that the device is not in use by the system prior to removal to avoid data loss.

6. Remove the physical disk from the system.



Attention: Do not install the replacement disk at this time.

7. Press Enter to complete removing the failed disk.

Installing a new disk

Use the iprconfig utility to install a new disk after the failed disk has been removed.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Concurrent Device Add.

The resulting screen is similar to the following example:

```
Concurrent Device Add
Choose a single location for add operations
1=Select
OPT Name Platform Location Description Status
U5888.001.6BAH025-P1-D6 Empty
U5888.001.6BAH025-P1-D7 Empty
```

| U5888.001.6BAH025-P1-F8 | | 1.6BAH025-P1-F8 | Empty | |
|-------------------------|----------|-----------------|-------|--|
| e=Exit | q=Cancel | t=Toggle | | |

- 3. Select the location to install the device by typing 1; then, press Enter.
- If you do not see the location to install, press \pm to toggle the dual path locations.
- 4. Verify the location of the device to install. The identify indicator must now be set. Press Enter.
- 5. Install the physical disk into the system.
- 6. Press Enter.

What to do next

If a hot-spare disk was available and kept your disk array protected throughout the failure, no additional steps are required because the hot spare has replaced the failed disk unit in the disk array, and the newly installed disk is available to be configured as a hot spare.

If a hot spare rebuild was not initiated by the controller, a rebuild needs to be initiated on the newly installed disk.

Related tasks

Rebuilding a newly installed disk

If a hot spare rebuild operation is not initiated by the controller when you have installed a new disk, you must initiate a rebuild operation before the disk is recognized by the system.

Rebuilding a newly installed disk

If a hot spare rebuild operation is not initiated by the controller when you have installed a new disk, you must initiate a rebuild operation before the disk is recognized by the system.

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select the disk you want to rebuild; then, press Enter.



Attention: Data currently on the disk will be overwritten.

4. To rebuild data, press Enter. If you do not want to rebuild data, type q to cancel.

Disk failure recovery

The IBM SAS RAID controller handles disk failures differently, depending on the RAID level involved.

The recovery procedure you use will depend on the level of the RAID adapter.

For a description of disk array and physical disk states, see <u>"Disk array overview" on page 22</u>. For a description of RAID levels, see "Supported RAID levels" on page 14.

RAID 0 failure

RAID 0 does not provide data protection. A single disk failure causes a RAID 0 array to transition to the Failed state.

If a single disk failure causes a RAID 0 array to transition to the Failed state, you must delete the disk array, replace the disk that is Failed , and recreate the disk array. You must then recreate the file systems on the disk array, and copy data back to the restored disk array from your backup media.

RAID 5 disk recovery

RAID 5 protects data with parity information distributed on all member disks.

The data can be recovered from the remaining disks if one disk fails.

Recovering a RAID 5 single-disk failure

RAID 5 protects the data with parity information distributed on all member disks. The data can be recovered from the remaining disks if one disk fails.

About this task

When a single disk in a RAID 5 disk array fails, the disk array status changes to Degraded. The disk array remains functional because the data on the failed disk can be rebuilt using parity and data on the remaining disks. If a hot-spare disk is available, the controller can rebuild the data on the disk automatically. If a hot-spare disk is not available, you must replace the failed disk and then initiate a rebuild.

Complete the following steps to initiate a rebuild:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Rebuild disk unit data.
- 4. Select the disks you want to rebuild, then press Enter.
- 5. To rebuild data, press Enter. If you do not want to rebuild data, type q to cancel.



Attention: Data currently on the disk will be overwritten.

RAID 5 multiple-disk failure

If a second disk in a RAID 5 disk array fails, the array also fails and its data is not accessible.

If a second disk in a RAID level 5 disk array fails, you must replace the failed disks, then delete and recreate the disk array. You must then recreate the file systems on the disk array and copy data to the restored disk array from your backup media.

RAID 6 disk recovery

RAID 6 protects data with dual parity information distributed on all member disks.

The data is recoverable from the remaining disks if one or two disks fail. If a third disk in a RAID 6 disk array fails, the data is not recoverable.

Recovering a RAID 6 single-disk or dual-disk failure

Whenever one or two disks in a RAID 6 disk array transitions to the Failed state, the disk array status changes to Degraded. The disk array remains functional because the data on the failed disk can be rebuilt using P and Q parity and data on the remaining disks.

Before you begin

Whenever a disk is marked as Failed, replace it as soon as possible. If a hot-spare disk is available, the controller can rebuild the data on the disk automatically. If a hot-spare disk is not available, you will need to replace the failed disk and then initiate a rebuild.

Complete the following steps to initiate a rebuild:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Rebuild disk unit data.
- 4. Select the disks you want to rebuild, then press Enter.
- 5. To rebuild data, press Enter. If you do not want to rebuild data, type q to cancel.



Attention: Data currently on the disk will be overwritten.
RAID 6 failure of three or more disks

If a third disk in a RAID 6 disk array fails, the array is marked as Failed and its data is not accessible.

If a third disk in a RAID 6 disk array fails, you must replace the failed disks, then delete and recreate the disk array. You must then recreate the file systems on the disk array and copy data to the restored disk array from your backup media.

RAID 10 disk recovery

RAID 10 protects the data on mirrored disk pairs.

Data can be recovered unless both disks of a mirrored disk pair fails.

Recovering a RAID 10 single-disk failure

When a single disk in a RAID 10 disk array fails, the disk array status changes to Degraded. The disk array remains functional because the data on the Failed disk is also stored on the other member of its mirrored pair.

Before you begin

When ever a disk fails, replace it as soon as possible. If a hot-spare disk is available, the controller can rebuild the data on the disk automatically. If a hot-spare disk is not available, you will need to replace the failed disk and then initiate a rebuild.

Complete the following steps to initiate a rebuild:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select **Rebuild disk unit data**.
- 4. Select the disks you want to rebuild, then press Enter.
- 5. To rebuild data, press Enter. If you do not want to rebuild data, type q to cancel.



Attention: Data currently on the disk will be overwritten.

RAID 10 multiple-disk failure

The procedure for handing a RAID 10 multiple-disk failure depends on whether the failed disk is on the same mirrored pair or on a different mirrored pair.

If each failed disk belongs to a different mirrored pair, then the array is in the Degraded state because the data on each failed disk is still available from its mirrored pair. The recovery procedure for this case is the same as that for a single-disk failure case where you initiate the rebuild operation after you replace the failed disks.

When both members of a mirrored pair fail, the disk array status changes to Failed. You must delete the disk array, replace the failed disks, and then recreate the disk array. You must then recreate the file systems on the disk array and copy data to the restored disk array from your backup media.

Viewing SAS fabric path information

Use the iprconfig utility to view details of the SAS fabric information.

Procedure

- 1. Type iprconfig and press Enter.
- 2. Select Work with disk unit recovery.
- 3. Select **Display SAS path status**.
- 4. Select the device by typing 1 in the OPT field.

The resulting screen is similar to the following example:

| + | Displa | y SAS Pa [.] | th Details | |
|--|---|-----------------------|--|---|
| Device Location SAS Address | Description | Active | /dev/sg3 0/00-04-05 Status | Info |
| 00000005 0000FF/500507604B809D41 00001E/500507604AC00DB0 000005/500507604AC00DB0 000001/500051610004B542 00000405 0004FF/500507604B809D45 0004C2/500507604AC00DB4 000405/500507604AC00DB4 000400/500051610004B541 000405/500051610004B540 e=Exit q=Cancel | Resource Path IOA Port Expander Port Device port Device LUN Resource Path IOA Port Expander Port Expander Port Device port Device LUN | Yes | Healthy Functional Functional Functional Functional Healthy Functional Functional Functional Functional Functional Functional | 6.0Gbps 6.0Gbps 6.0Gbps Enabled 6.0Gbps 6.0Gbps 6.0Gbps 6.0Gbps 6.0Gbps 6.0Gbps Enabled |

| Table 15. Possible values for the SAS path status | | | | |
|---|--|--|--|--|
| Status | Description | | | |
| Functional | No problem detected | | | |
| Degraded | Aded The SAS node is degraded | | | |
| Failed | The SAS node is failed | | | |
| Suspect ¹ | The SAS node is suspected of contributing to a failure | | | |
| 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 the node is not displayed. | | | | |

Viewing SCSI location and physical resource path

Use the iprconfig utility to view the Serial Computer System Interface (SCSI) location and physical resource path of a device.

Procedure

- 1. Type iprconfig and press Enter.
- 2. Select Display hardware status.
- 3. Select the device by typing 1 in the OPT field.

The resulting screen is similar to the following example:

```
      Disk Unit Hardware Resource Information Details

      Manufacturer.
      IBM

      Product ID.
      V2-TX21B10400G

      Firmware Version.
      30473330 (0G30)

      Serial Number.
      50401GDG

      Capacity.
      387.96 GB

      Physical location
      0000:01:00.0

      Resource Path.
      00-04-05

      SCSI Host Number
      0
```

| SCSI Id SCSI Lun Platform Location | | · · · · · · · · · · · · · · · · · · · | 3 0 U5888.001.6BAH025-P1-C1-P1-D6 | |
|--|----------|---------------------------------------|---|---|
| Capacity Exteded Details Press Enter to Conti | inue | | 387.96 GB | |
| e=Exit q=Cancel | f=PageDn | b=PageUp | | _ |

Reclaiming IOA cache storage

A reclamation procedure for the I/O adapter (IOA) cache storage is sometimes used to resolve cache problems. Perform this procedure only if directed to do so by a maintenance analysis procedure (MAP).

Before you begin



Attention: Data may be lost. When an auxiliary cache adapter connected to the RAID controller logs a 9055 URC in the error log, the Reclaim procedure does not result in lost sectors. Otherwise, the Reclaim procedure will result in lost sectors.

Complete the following steps to reclaim IOA cache storage:

Procedure

- 1. Run the iprconfig utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Reclaim IOA cache storage.
- 4. Select the desired adapter, then press Enter.

A screen display will then show the devices that might be affected.

5. To reclaim IOA cache storage, type c to confirm. If you do not want to reclaim IOA cache storage, type q to cancel.

A screen display similar to one of the following will then be displayed.

Problem determination and recovery

Several tools are available that the trained service representative can use to identify and recover from problems.

Trained service representatives use error logs, Unit Reference Code tables, and maintenance analysis procedures (MAPs) in problem determination and recovery procedures.

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. For additional sources of related service procedures required to service this subsystem, see "Related information" on page 10.

If a problem arises related to disk arrays and associated physical disks, use the following to identify the problem:

- **ipr** error log entries associated with the problem, viewed using the **Analyze Log** option in iprconfig or directly from /var/log/messages
- Disk array and physical disk status, viewed using the iprconfig utility

Entries in the error log contain a Unit Reference Code (URC) and a description of the problem. Each URC corresponds to an action that should be taken. It is sometimes recommended that you perform a MAP to further determine what actions should be taken to resolve the problem.

This topic collection provides many of these MAPs. The MAPs are intended to address only problems directly related to disk arrays and SAS cabling problem isolation. MAPs related to other device or adapter problems, when applicable, are located in other Linux system documentation.

Analyzing error logs

The experienced user can search through this file with commands, such as grep and sed, but the iprconfig utility also offers a convenient menu for analyzing the error log.

About this task

Errors logged by the adapters and devices are stored in the /var/log/messages file. Options on the error log screen that are not mentioned here are used to gather certain information from the error log and present it in the default editor. This is used mostly during Maintenance Analysis Procedures to search for Unit Reference Codes.

Procedure

1. Select Analyze Log from the main menu in iprconfig.

A screen will display information similar to the following:

```
Kernel Messages Log
Select one of the following:

1. View most recent ipr error messages

2. View ipr error messages

3. View all kernel error messages

4. View iprconfig error messages

5. Set root kernel message log directory

6. Set default editor

7. Restore defaults

8. View IBM boot time messages

Selection:

e=Exit q=Cancel
```

2. To change the directory where the error log is stored, use the **Set root kernel message log** directory option.

Normally, this does not need to be used. It can be useful when booting from an alternate root file system if you want to access /var/log/messages on another file system.

3. To change the text editor used to view the error log from the default text editor, **vi**, choose the **Set default editor** option.

Invoking iprconfig with the **-e** command line option will also change the default editor. Type the command iprconfig -h for more information.

4. To return the location of the error log to /var/log/messages and set the default editor back to **vi**, choose the **Restore defaults** option.

Basic vi commands

There are several frequently-used vi commands.

| Table 16. Frequently-used vi commands | | | | |
|---------------------------------------|--|--|--|--|
| Command | Action | | | |
| h | Move cursor to the right (in case arrow keys have no effect) | | | |
| j | Move cursor down (in case arrow keys have no effect) | | | |
| k | Move cursor up (in case arrow keys have no effect) | | | |
| 1 | Move cursor to the left (in case arrow keys have no effect) | | | |
| CTRL-f | Page down (forward) | | | |
| CTRL-b | Page up (backward) | | | |
| nG | Go to line number <i>n</i> . If n is omitted, go to the last line in file. | | | |
| /pattern | Search forward for pattern. After searching, type n to repeat the search. | | | |
| ?pattern | Search backward for pattern. After searching, type n to repeat the search. | | | |
| n | Repeat the previous search | | | |
| :q | Quit vi and return to the iprconfig utility | | | |

Searching logs

Use commands similar to these to perform a search on an error log.

About this task

The steps in this procedure are presented as a sample search for the URC **3400**. Replace the variable **3400** with your own search term.

Procedure

- 1. From the Kernel Messages Log screen, select the **Use vi to view most recent ipr error messages** option.
- 2. Type G to move to the last line of the file.
- 3. Type ?3400 and press Enter to search backward for the pattern "3400."
- 4. If the first instance found is not part of an error log entry header, repeat the command by typing n as necessary.

Samples: Error logs

When viewed through iprconfig, ipr error messages are displayed in various formats.

The first portion of the log entry is the header, which contains important information such as the Unit Reference Code (URC), the error class, the IOA under which the error occurred, the error description text, and the hardware location. The last block of data in the entry is the IOA error data, which is data recorded by the IOA to assist with recovery, if the recommended service action did not solve the problem.

Sample: Generic IOA or device error log

Sample generic IOA or device error log

The generic IOA or device error log provides information in the following format:

| - | + | | | | | | | | + |
|---|------------|------------|------------|-----------|-----------|----|-----|-----|---|
| | 2:0:9:0: | FFFE: Soft | t device H | bus error | recovered | by | the | IOA | i |
| | 000000000: | 01080000 | 00000900 | FFFFFFF | 1104E092 | | | | 1 |
| | 00000010: | 00000000 | 00000002 | 00000000 | 00000000 | | | | 1 |
| | 00000020: | 00000000 | 00000000 | 00000000 | 00000000 | | | | ĺ |
| | 00000030: | 00000000 | 00000000 | 0034D780 | 00000900 | | | | 1 |
| | 00000040: | 00000311 | 041F1CC7 | 0000E092 | 0000E092 | | | | |
| | 00000050: | 0000E092 | 0000E092 | 0000E092 | 0000E092 | | | | 1 |
| | 00000060: | 28282828 | 28282828 | D000100F | 00052800 | | | | 1 |
| | 00000070: | 041F1CC7 | 00000100 | 00000000 | 90280000 | | | | |
| | 00000080: | 00000500 | 00000000 | 0C804000 | 00CCDDDD | | | | |
| | 00000090: | 00000000 | 00000000 | 49000000 | 00315208 | | | | |
| | 000000A0: | 83000000 | 40010000 | 80000000 | 28E30000 | | | | |
| | 000000B0: | 000001F4 | 00000000 | 00000000 | 00000000 | | | | |
| | 0000000000 | 00000000 | 00000000 | 00000000 | 00000000 | | | | |
| | 000000D0: | 00000000 | 00000000 | 00000000 | 00000000 | | | | |
| | 000000E0: | 00000000 | 00000000 | 00000000 | 00000000 | | | | |
| | 000000F0: | 00000000 | 00000000 | 00000000 | 0034D780 | | | | |
| | 00000100: | 00000000 | FFFFFFF | 00000000 | 00000000 | | | | |
| | 00000110: | 00000000 | 53544154 | E00000A2 | 0034D780 | | | | |
| - | | | | | | | | | + |

Sample: Device configuration error log

Sample device configuration error log

The device configuration error log provides information in the following format:

Sample: Array error log

Sample array error log

The array error log provides information in the following format:

```
0001:61:01.0: 9030: Array no longer protected due to missing or failed disk unit
RAID 10 Array Configuration: 2:255:0:0
```

| | Exposed Array Member 0: | |
|---|---|--|
| L | Vendor/Product ID: IBM IC35L036UCDY10-0 | |
| L | Serial Number: E3V1WEAB | |
| | WWN: 5000CCA00336F4AC | |
| | Current Location: 2:0:4:0 | |
| | Expected Location: 2:0:4:0 | |
| | | |
| | Array Member 1: | |
| | Vendor/Product ID: IBM IC35L036UCDY10-0 | |
| | Serial Number: E3V0J55B | |
| | WWN: 5005076C0400C703 | |
| | Current Location: 2:0:5:0 | |
| | Expected Location: 2:0:5:0 | |
| + | | |

Sample: Cache error log

Sample cache error log

The cache error log provides information in the following format:

```
0001:61:01.0: 9010: Cache data associated with attached devices cannot be found
Cache Directory Card Information:
Vendor/Product ID: IBM 570300
                              5703001
    Serial Number: 03060038
WWN: 5005076C03023F00
Adapter Card Information:
Vendor/Product ID: IBM
                               5703001
    Serial Number: 03060038
WWN: 5005076C03023F00
-----Expected Configuration-
Cache Directory Card Information:
Vendor/Product ID:
    Serial Number:
               WWN: 0000000000000000
Adapter Card Information:
Vendor/Product ID: IBM
                               5703001
    Serial Number: 03060038
WWN: 5005076C03023F00
Additional IOA Data: 00000000 00000000 152101D0
```

Disk array problem identification

A disk array problem is uniquely identified by a Unit Reference Code (URC).

A URC is used to indicate the specific problem that has occurred. This code is required in order to determine which MAP to use.

A URC is provided in the ipr error log with each error. This URC describes the exact problem that has been detected and is considered the primary means of identifying a problem. However, the **Display Hardware Status** screen within the iprconfig utility is also a useful tool in identifying a problem or confirming a problem described by the error log. For additional information about this status screen, see <u>"Viewing</u> device status" on page 29.

When you have obtained the URC, you can then determine which Maintenance Analysis Procedure (MAP) to use.

Unit reference code tables

Use the information in this section, along with the unit reference code (URC) obtained from the ipr error log, to determine which maintenance analysis procedures (MAPs) to use.

| Table 17. URC | Table 17. URC | | | | | |
|---------------|---|--|--|--|--|--|
| URC | Description text | Service action | Failing items | | | |
| 102E | Out of alternate sectors for disk storage | Exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform <u>"MAP</u> 3351" on page 92. | Disk drive | | | |
| 3002 | Addressed device failed to respond to selection | Exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform <u>"MAP</u> 3351" on page 92. | Disk drive | | | |
| 3010 | Disk device returned wrong response to IOA | Exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform <u>"MAP</u> 3351" on page 92. | Disk drive | | | |
| 3020 | Storage subsystem configuration error IOA detected a SAS fabric configuration error | Perform <u>"MAP 3350" on</u> page 90 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |
| 3029 | A device replacement has occurred | No action required. | | | | |
| 3100 | Device bus error | A SAS fabric error occurred. Perform <u>"MAP</u> <u>3350" on page 90</u> . | | | | |
| 3109 | IOA timed out a device command | Perform <u>"MAP 3350" on</u> page 90. | | | | |
| 310D | Logical block reference tag error detected by the IOA | Controller T10 DIF host bus error. Perform <u>"MAP</u> <u>3350" on page 90</u> . | | | | |
| | detected by the IOA | | | | | |
| 3400 | Device, I/O Adapter, Any device on I/O bus, Signal cables | Exchange the failing items in the Failing Items list one at a time. | Device, I/O Adapter, Any device on I/O signal cables | | | |
| 4010 | Incorrect connection between cascaded expanders | Perform "MAP 3342" on page 87 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |

| Table 17. URC (continued) | | | | | | |
|---------------------------|--|--|---------------|--|--|--|
| URC | Description text | Service action | Failing items | | | |
| 4020 | Connections exceed IOA design limits | Perform <u>"MAP 3343" on</u> page 88 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 4030 | Incorrect multipath connection | Perform <u>"MAP 3344" on</u> page 88 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 4040 | Incomplete multipath connection between IOA and enclosure | Perform <u>"MAP 3344" on</u> page 88 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 4041 | Incomplete multipath connection between enclosure and device | Perform <u>"MAP 3346" on</u> page 89 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |
| 4050 | Enclosure does not support a required multipath function | Perform <u>"MAP 3348" on</u> page 89 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 4060 | Multipath redundancy level got worse | Perform <u>"MAP 3353" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 4061 | Multipath redundancy level got better | No action required. | | | | |
| 4080 | IOA exceeded maximum operating temperature | Perform <u>"MAP 3495" on</u> page <u>112</u> for a PCIe3 controller. | | | | |
| 4085 | Service required | Perform <u>"MAP 3490" on</u> page 111. | | | | |
| 4086 | SAS adapter hardware configuration error | Perform <u>"MAP 3496" on</u> page 112. | | | | |
| 4100 | Hard device bus fabric error | Perform <u>"MAP 3352" on</u> page 93. | | | | |
| 4101 | Soft device bus fabric error | Perform <u>"MAP 3352" on</u> page 93. | | | | |
| 4102 | Device bus fabric performance degradation | Perform <u>"MAP 3490" on</u> page 111. | | | | |

| Table 17. URC (continued) | | | | | |
|---------------------------|---|---|---------------------------------|--|--|
| URC | Description text | Service action | Failing items | | |
| 4110 | Unsupported enclosure function | Perform "MAP 3345" on page 88. | | | |
| 4120 | SAS cable VPD cannot be read | Perform <u>"MAP 3461" on</u> page 111 for a PCIe3 controller. | | | |
| 4121 | Configuration error, required cable is missing | Perform "MAP 3461" on page 111. | | | |
| 4123 | Configuration error, invalid cable vital product data | Perform <u>"MAP 3461" on</u> page 111. | | | |
| 4170 | Scatter list tag / sequence number error Logical block sequence number error on IOA to Host transfer | Controller recovered T10 DIF host bus error. Perform <u>"MAP 3390" on</u> page 94 | | | |
| 4171 | Recovered scatter list tag / sequence number error Recovered logical block sequence number error on IOA to Host transfer | Controller T10 DIF host bus error. Perform <u>"MAP</u> 3390" on page 94 | | | |
| 7001 | IOA sector reassignment successful | If three 7001 messages have occurred for the same disk drive location, then exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform "MAP 3351" on page 92. | Disk drive | | |
| 8150 | Permanent IOA failure | Exchange the failing items in the Failing Items list one at a time. | I/O adapter | | |
| | PCI bus error | If two errors have occurred for the same I/O adapter in 24 hours, exchange the failing items in the Failing Items list one at a time. | Any device on I/O signal cables | | |

| Table 17. URC (continued) | | | | | | |
|---------------------------|--|--|---------------|--|--|--|
| URC | Description text | Service action | Failing items | | | |
| 8151 | IOA microcode error | Update adapter microcode. See <u>"Updating the controller</u> <u>microcode" on page 55</u> . If the problem is not resolved, exchange the failing items in the Failing Items list one at a time. | I/O adapter | | | |
| 8157 | IOA error requiring IOA reset to recover | If two 8157 messages have occurred for the same I/O adapter location, exchange the failing items in the Failing Items list one at a time. | I/O adapter | | | |
| 9000 | IOA reserved area data check | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9001 | IOA reserved area invalid data pattern | Perform <u>"MAP 3337" on</u> page 86 for a PCIe controller or MAP 3450 for a PCIe3 controller. | | | | |
| 9002 | IOA reserved area LRC error | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9008 | IOA does not support functions expected by devices | Perform <u>"MAP 3330" on</u> page 78 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9020 | Array missing two or more devices with only one device present | Perform <u>"MAP 3311" on</u> page 76 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |
| 9021 | Array missing two or more devices with two or more devices present | Perform <u>"MAP 3311" on</u> page 76 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |

| Table 17. URC (continued) | | | | | |
|---------------------------|--|--|---------------|--|--|
| URC | Description text | Service action | Failing items | | |
| 9022 | Exposed array is missing a required device | Perform <u>"MAP 3311" on</u> page 76 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9023 | Array members not at required physical locations | Perform <u>"MAP 3312" on</u> page 76 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | |
| 9024 | Array not functional due to present hardware configuration | Perform <u>"MAP 3390" on</u> page 94. | | | |
| 9025 | Disk unit is not supported at its physical location | Perform <u>"MAP 3310" on</u> page 75. | | | |
| 9026 | Array not functional due to present hardware configuration | Perform <u>"MAP 3390" on</u> page 94. | | | |
| 9027 | Array is missing a device and parity is out of sync | Perform <u>"MAP 3313" on</u> page 77 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9028 | Maximum number of arrays already exist | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or < <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9029 | Incorrect hardware configuration change has been detected | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9030 | Array no longer protected due to missing or failed disk unit | Perform "MAP 3310" on page 75 for a PCIe controller or "MAP 3450" on page 107 for a PCIe3 controller. | | | |
| 9031 | Array protection temporarily suspended, protection resuming | Perform <u>"MAP 3310" on</u> page 75 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |

| Table 17. URC (continued) | | | | | | |
|---------------------------|--|--|---------------|--|--|--|
| URC | Description text | Service action | Failing items | | | |
| 9032 | Array exposed but still protected | Perform <u>"MAP 3310" on</u> page 75 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |
| 9040 | Array protection temporarily suspended, protection resuming | No action required. The array is synching. Wait until the synch is complete. | | | | |
| 9041 | Array protection temporarily suspended | Background array parity checking detected and errors corrected. Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9042 | Corrupt array parity detected on specified device | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9050 | Required cache data can not be located for one or more disks | Perform <u>"MAP 3331" on</u> page 79 for PCI_X or PCIe controller or <u>"MAP</u> 3431" on page 99 for a PCIe3 controller | | | | |
| 9051 | Cache data exists for one or more missing or failed disks | Perform "MAP 3332" on page 82 for PCI_X or PCIe controller or "MAP 3432" on page 101 for a PCIe3 controller | | | | |
| 9052 | Cache data exists for one or more modified disks | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | | |
| 9054 | IOA resources not available due to previous problems | Perform <u>"MAP 3321" on</u> page 78 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | | |
| 9060 | One or more disk pairs are missing from an array | Perform "MAP 3311" on page 76 for a PCIe controller or MAP 3450 for a PCIe3 controller. | | | | |

| Table 17. URC (continued) | | | | | |
|---------------------------|---|---|---|--|--|
| URC | Description text | Service action | Failing items | | |
| 9061 | One or more disks are missing from an array | Perform <u>"MAP 3311" on</u> page 76 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9062 | One or more disks are missing from an array | Perform <u>"MAP 3311" on</u> page 76 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9063 | Maximum number of functional arrays has been exceeded | Perform <u>"MAP 3390" on</u> page 94 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9073 | Invalid multi-adapter configuration | Multiple controllers connected in an invalid configuration. Perform "MAP 3340" on page 87 | | | |
| 9074 | Multiple controllers are not capable of similar functions or of controlling the same set of devices | Perform <u>"MAP 3341" on</u> page 87 for a PCIe3 controller. | | | |
| 9075 | Incomplete multipath connection between IOA and remote IOA | Perform "MAP 3349" on page 89 for a PCIe controller or "MAP 3450" on page 107 for a PCIe3 controller. | | | |
| 9076 | Configuration error, missing remote IOA | Missing remote controller. Perform "MAP 3347" on page 89 | | | |
| 9081 | IOA detected device error | Exchange the failing items in the Failing Items list one at a time. | Disk drive, I/O adapter | | |
| 9082 | IOA detected device error | Exchange the failing items in the Failing Items list one at a time. | Disk drive I/O adapter signal cables backplane any device on I/O signal cables | | |

| Table 17. URC (continued) | | | | | |
|---------------------------|---|---|---------------|--|--|
| URC | Description text | Service action | Failing items | | |
| 9090 | Disk unit has been modified after the last known status | Perform <u>"MAP 3333" on</u> page 83 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9091 | Incorrect hardware configuration change has been detected | Perform <u>"MAP 3333" on</u> page 83 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| 9092 | Disk unit requires initialization before use | Perform <u>"MAP 3334" on</u> page 83 for a PCIe controller or <u>"MAP</u> <u>3450" on page 107</u> for a PCIe3 controller. | | | |
| FF3D | Soft IOA error recovered by the IOA Soft PCI bus error recovered by the IOA | If 10 FF3D messages have occurred for the same I/O Adapter physical location within a week, then exchange the failing items in the Failing Items list one at a time. | I/O adapter | | |
| FFF3 | Disk media format bad | Perform <u>"MAP 3335" on</u> page 85 for a PCIe controller or <u>"MAP</u> 3450" on page 107 for a PCIe3 controller. | | | |
| FFF4 | Disk device problem Command to logical unit failed Device microcode is corrupt Data transfer overlength error Data transfer underlength error | Exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform <u>"MAP</u> 3351" on page 92. | Disk drive | | |
| FFF6 | Failure prediction threshold exceeded | Exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform <u>"MAP</u> 3351" on page 92. | Disk drive | | |
| | Device hardware error recovered by the device Device hardware error recovered by the IOA | No action required. | | | |

| Table 17. URC (continued) | | | | | |
|---------------------------|--|---|---------------|--|--|
| URC | Description text | Service action | Failing items | | |
| FFF7 | Media error recovered by IOA rewrite procedures Media error recovered by device rewrite procedures | No action required. | | | |
| FFF9 | Soft media error. Sector reassignment recommended Device sector reassign successful | No action required. | | | |
| FFFA | Undefined device response recovered by the IOA | If 10 FFFA messages have occurred for the same disk drive location in a one-week time period, then exchange the failing items in the Failing Items list one at a time. If the problem is not resolved, perform "MAP 3351" on page 92. | Disk drive | | |
| FFFB | SCSI bus was reset | No action required. | | | |
| FFFC | Logical block guard error recovered by the device Logical block reference tag error recovered by the device | Device recovered T10 DIF device bus error. Perform <u>"MAP 3350" on</u> page 90. | | | |
| FFFD | Recovered logical block reference tag error detected by the IOA Logical block guard error recovered by the IOA | Controller recovered T10 DIF device bus error. Perform <u>"MAP</u> 3350" on page 90. | | | |
| FFFE | Soft device bus error recovered by the IOA | If 10 statistical FFFE messages have occurred for the same disk drive location in a one-week time period, perform "MAP 3350" on page 90 for a PCIe controller or "MAP 3450" on page 107 for a PCIe3 controller. | | | |

Maintenance analysis procedures

Use these procedures to resolve adapter, cache, or disk array problems associated with your controller. For help in determining which MAP to use, see "Unit reference code tables" on page 66.

MAP 3310

Use this MAP to resolve the following problems:

- Disk unit is not supported at its physical location (URC 9025) for a PCIe controller
- Array no longer protected due to missing or failed disk unit (URC 9030) for a PCIe controller
- Array protection temporarily suspended (URC 9031) for a PCIe controller
- Disk Array is degraded due to missing or failed disk (URC 9032) for a PCIe controller

Step 3310-1

Identify the disk array by examining the error log and the Display Disk Array Status screen. For information regarding accessing the Display Disk Array Status screen, see <u>"Viewing array status" on page 31</u>.

Go to "Step 3310-2" on page 75

Step 3310-2

Does a disk array have a state of Degraded?

NO Go to <u>"Step 3310–3" on page 75</u>.

YES Go to "Step 3310-4" on page 75.

Step 3310-3

The affected disk array should have a status of either *Rebuilt* or *Active* due to the use of a *Hot Spare* disk. Create a new *Hot Spare* disk for the disk array by doing the following:

- 1. Identify the failed disk using the **Display Hardware Status** screen. For details, see <u>"Viewing array</u> status" on page 31. The failed disk should have a status of *Failed*.
- 2. Remove the failed disk and replace it with a new disk that will be used as the *Hot Spare*. For details, see "Physical disks" on page 56.
- 3. The new disk must be formatted for *Advanced Function* in order to be used as a hot spare. If the new disk needs to be formatted, see "RAID and JBOD formats" on page 32.
- 4. Assign the new disk as a hot spare for the disk. For details, see "Hot-spare disks" on page 36.

When the problem is resolved, go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Step 3310-4

The Failed disk should be replaced by using the following procedure:

- 1. Identify the failed disk by using the Display Hardware Status screen. For details, see <u>"Viewing array</u> status" on page 31. The failed disk should have a status of *Failed*.
- 2. Remove the failed disk, replace it with a new disk, and rebuild the disk unit data. For details, see "Physical disks" on page 56.

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.

When the problem is resolved, go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Use this MAP to resolve the following problems:

- Array not functional due to present hardware configuration (URC 9020 / 9021 / 9022) for a PCIe controller
- One or more disk pairs are missing from an array (URC 9060) for a PCIe controller
- One or more disks are missing from an array (URC 9061 / 9062) for a PCIe controller

Step 3311–1

Identify the disks missing from the disk array by examining the error log and the **Display Hardware Status** screen. For details, see "Viewing array status" on page 31.

Go to <u>"Step 3311–2" on page 76</u>.

Step 3311-2

There are three possible ways to correct the problem. Perform only one of the following three options, listed in the order of preference:

- Locate the missing disks and install them in the correct physical locations in the system. Then, IPL the system or logical partition (it may be necessary to boot into Rescue mode), or reset the adapter by performing the following:
 - 1. Find the scsi host number associated with the adapter by using the **Display Hardware Status** screen. For more details see Viewing the Status of Disks and Disk Arrays.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.

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

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



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

- 1. the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you wish to format then press Enter.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3312

Use this MAP to resolve the following problem:

• Array members not at required resource address (URC 9023) for a PCIe controller

Step 3312-1

Identify the disks that are not at their required physical locations by using the error log entry and the **Display Hardware Status** screen. For details, see <u>"Viewing device status" on page 29</u>.

Go to <u>"Step 3312–2" on page 77</u>.

Step 3312-2

There are three possible ways to correct the problem. Perform only one of the following three options, listed in the order of preference:

- Locate the missing disks and install them in the correct physical locations in the system. Then, IPL the system or logical partition (it may be necessary to boot into *Rescue* mode), or reset the adapter by performing the following:
 - 1. Find the scsi host number associated with the adapter by using the Display Hardware Status screen. For more details see Viewing the Status of Disks and Disk Arrays.
 - 2. Use the echo 1 > /sys/class/scsi host/hostX/reset host command to reset the adapter, where X is the scsi host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.



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

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



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

- 1. Run the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you wish to format then press Enter.

When the problem is resolved, go to MAP 0410: Repair Checkout in RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems.

MAP 3313

Use this MAP to resolve the following problem:

Array not functional due to present hardware configuration (URC 9027) for a PCIe controller

Step 3313-1

Identify the adapter and disks related to the error by examining the error log and the **Display Hardware** Status screen. For details, see "Viewing device status" on page 29.

Go to "Step 3313-2" on page 77.

Step 3313-2

Have the disks or adapter card been physically moved recently?

NO Contact your service support organization.

YES Go to "Step 3313-3" on page 77.

Step 3313-3

There are three possible ways to correct the problem. Perform only one of the following three options, listed in the order of preference:

- Restore the adapter and disks back to their original configuration. Then, IPL the system or logical partition (it may be necessary to boot into *Rescue* mode), or reset the adapter by performing the following:
 - 1. Find the scsi host number associated with the adapter by using the Display Hardware Status screen. For more details see "Viewing device status" on page 29.

- 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.

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

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



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

1. Select Work with disk unit recovery.

- 2. Select Initialize and format disk unit.
- 3. Select the drives you wish to format then press Enter.
- 4. Run the **iprconfig** utility by typing iprconfig.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3320

Use this MAP to resolve the following problem:

• Cache data associated with attached disks cannot be found (URC 9010) for a PCIe controller

Step 3320-1

Contact your service support organization.

MAP 3321

Use this MAP to resolve the following problems:

• IOA resources not available due to previous problems (URC 9054) with a PCIe controller

The possible causes follow:

- 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 PCIe3 controller to a PCIe controller.

Step 3321-1

Perform the following:

1. Remove any new or replacement disks which have been attached to the adapter.

2. Take action on the other errors which have occurred at the same time as this error.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3330

Use this MAP to resolve the following problem:

• IOA does not support functions expected by devices (URC 9008)

Step 3330-1

Identify the affected disks by examining the error log and the **Display Hardware Status** screen. For details, see <u>"Viewing device status" on page 29</u>.

Go to "Step 3330-2" on page 79.

Step 3330-2

Have the adapter card or disks been physically moved recently?

NO Contact your service support organization.

YES Go to "Step 3330-3" on page 79.

Step 3330-3

There are two possible ways to correct the problem. Perform only *one* of the following two options, listed in the order of preference:

- Restore the adapter and disks back to their original configuration; then, either IPL the system or logical partition (it may be necessary to boot into *Rescue* mode) or reset the adapter by performing the following:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details see Viewing the Status of Disks and Disk Arrays.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.
- Format the remaining members of the disk array, as follows:

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

- 1. Run the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you wish to format then press Enter.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3331

Use this MAP to resolve the following problem:

• Required cache data cannot be located for one or more disks (URC 9050) for a PCIe controller

Step 3331–1

Did you just exchange the adapter as the result of a failure?

NO Go to "Step 3331-6" on page 80.

YES Go to "Step 3331-2" on page 79.

Step 3331-2

Is the adapter connected in an HA RAID configuration (that is, two adapters connected to the same set of disks)?

NO Go to "Step 3331-3" on page 79.

YES Contact your hardware service provider.

Step 3331–3

Are you working with a 572F/575C card set?

NO Go to "Step 3331–5" on page 80.

YES Go to <u>"Step 3331–4" on page 80</u>.

Step 3331-4

Note: Label all parts (original and new) before moving them.

Remove the 572F/575C card set by using the appropriate service procedures. 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

Go to <u>"Step 3331–11" on page 81</u>.

Step 3331-5

Notes:

- 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 performing an IPL 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.
- Label all parts (old and new) before moving them.

Remove the I/O adapter by using the appropriate service procedures. Install the new replacement storage I/O adapter with the following parts installed on it:

• 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 table for PCIe3 SAS RAID card comparison and is marked as **Yes** in the **Removable Cache Card** column.

Go to "Step 3331–11" on page 81.

Step 3331-6

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

- 1. View the error log and identify the affected disks.
- 2. Go to "Step 3331-7" on page 80.

Step 3331-7

Have the adapter or disks been physically moved recently?

NO Contact your hardware service provider.

YES Go to "Step 3331–8" on page 80.

Step 3331-8

Is the data on the disks needed for this or any other system?

NO Go to "Step 3331–10" on page 81.

YES Go to "Step 3331-9" on page 80.

Step 3331-9

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. After the cache data is written to the disks and the system is powered off normally, the adapter and disks can be moved to another location.

Step 3331-10

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

1. Reclaim controller cache storage by performing the following steps:



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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select Work with disk unit recovery.
- c. Select Reclaim IOA cache storage.
- d. Confirm to proceed.
- 2. If the disks are members of a disk array, delete the disk array by completing the following steps:

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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select **Work with disk array**.
- c. Select **Delete a disk array**.
- d. From the listed disk arrays, select the disk array you want to delete, and press Enter.
- 3. Format the disks by completing the following steps:

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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select Work with disk arrays.
- c. Select Format device for RAID function.
- d. From the list of eligible disk units, choose the disks you want to format for advanced function and press **Enter**.

Step 3331–11

Has a new URC 9010 or URC 9050 occurred?

NO Go to <u>"Step 3331–13" on page 82</u>.

YES Go to "Step 3331-12" on page 81.

Step 3331-12

Was the new URC 9050?

NO

The new SRN was URC 9010. Reclaim the controller cache storage by completing the following steps:



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 results in lost sectors.

- 1. Type **iprconfig** to run the iprconfig utility.
- 2. Select Work with disk unit recovery.
- 3. Select Reclaim IOA cache storage.
- 4. Go to "Step 3331-13" on page 82.

YES

Contact your hardware service provider.

Step 3331-13

Are you working with a 572F/575C card set?

NO Go to "Step 3331-15" on page 82.

YES Go to "Step 3331-14" on page 82.

Step 3331–14

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

Step 3331–15

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:

• 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 table for PCIe3 SAS RAID card comparison and is marked as **Yes** in the **Removable Cache Card** column.

MAP 3332

Use this MAP to resolve the problem: Cache data exists for one or more missing or failed disks (URC 9051) for a PCIe controller

The problem could arise due to the following causes:

- 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 3332–1

Identify the affected disks by examining the hardware error log. Complete the following steps to view the error log:

1. View the error log and identify the affected disk.

2. Go to "Step 3332-2" on page 82.

Step 3332-2

Are there other disk or adapter errors that have occurred at approximately the same time as this error?

NO Go to "Step 3332-3" on page 82.

YES Go to <u>"Step 3332–6" on page 83.</u>

Step 3332–3

Is the data on the disks and the cache data for the disks needed for this or any other system?

NOGo to <u>"Step 3332–7" on page 83</u>.

YES Go to <u>"Step 3332–4" on page 83</u>.

Step 3332-4

Have the adapter card or disks been physically moved recently?

NO Contact your hardware service provider.

YES Go to "Step 3332-5" on page 83.

Step 3332-5

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.

Step 3332-6

Take action on the other errors that have occurred at the same time as this error.

Step 3332-7

Reclaim the Controller Cache Storage by performing the following steps:

Note: Data will be lost.

- 1. Type **iprconfig** to run the iprconfig utility.
- 2. Select Work with disk unit recovery.
- 3. Select Reclaim IOA cache storage.
- 4. Confirm to proceed.

MAP 3333

Use this MAP to resolve the following problem:

- Disk unit has been modified after the last known status (URC 9090) for a PCIe controller
- Incorrect hardware configuration change has been detected (URC 9091) for a PCIe controller

Step 3333–1

IPL the system or logical partition (it may be necessary to boot into *Rescue* mode), or reset the adapter by performing the following:

- 1. Find the scsi host number associated with the adapter by using the **Display Hardware Status** screen. For more details see Viewing the Status of Disks and Disk Arrays.
- 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.

Take action on any new errors which surface.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems.*

MAP 3334

Use this MAP to resolve the following problem:

• Disk unit requires initialization before use (URC 9092) for a PCIe controller

The possible causes are:

- 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 **Device Concurrent Maintenance** screen in **iprconfig** when concurrently removing and installing disks (see <u>"Physical disks" on page 56</u>) or not performing a normal power down of the system prior to reconfiguring disks and adapters.
- Disk is member of a disk array, but was detected subsequent to the adapter being configured.
- Disk has multiple or complex configuration problems.

Step 3334-1

Identify the affected disks by examining the error log and the **Display Hardware Status** screen. For details, see <u>"Viewing device status" on page 29</u>.

Go to <u>"Step 3334–2" on page 84.</u>

Step 3334-2

Are there other disk or adapter errors that have occurred at about the same time as this error?

NO Go to "Step 3334-4" on page 84.

YES Go to "Step 3334-3" on page 84.

Step 3334-3

Take action on the other errors that have occurred at the same time as this error.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Step 3334-4

Have the disks or adapter card been physically moved recently?

NO Go to "Step 3334-5" on page 84.

YES Go to <u>"Step 3334–6" on page 84</u>.

Step 3334–5

Is the data on the disks needed for this or any other system?

NO Go to "Step 3334-7" on page 85.

YES Go to "Step 3334-6" on page 84.

Step 3334–6

There are three possible ways to correct this problem. Perform only one of the following three options:

- IPL the system or logical partition (it may be necessary to boot into *Rescue* mode), or reset the adapter by performing the following:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details see Viewing the Status of Disks and Disk Arrays.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.
- Restore the adapter and disks back to their original configuration. Then, IPL the system or logical partition (it may be necessary to boot into *Rescue* mode), or reset the adapter by performing the following:
 - 1. Find the scsi host number associated with the adapter by using the Display Hardware Status screen. For more details see <u>"Viewing device status"</u> on page 29.

- 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the scsi host number from the previous step.
- · Remove the disks from this adapter

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems.*

Step 3334–7

There are two possible ways to correct the problem. Perform only one of these options.

• Format the disks, as follows:

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

1. Run the **iprconfig** utility by typing iprconfig.

- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you wish to format then press Enter.
- If the disks are members of a disk array, delete the disk array. See <u>"Deleting an IBM SAS RAID disk</u> array" on page 35.

Note: In some rare scenarios, deleting the disk array will not have no effect on a disk and the disk must be formatted instead.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3335

Use this MAP to resolve the following problem:

• Disk media format bad (URC FFF3) for a PCIe controller

The possible causes are:

- Disk was being formatted and was powered off during this process.
- Disk was being formatted and was reset during this process.

Step 3335–1

Identify the affected disk by examining the error log and the **Display Hardware Status** screen. For details, see "Viewing device status" on page 29.

Go to <u>"Step 3335–2" on page 85</u>.

Step 3335-2

Format the disks, as follows:



Attention: All data on the disks will be lost.

1. Run the **iprconfig** utility by typing iprconfig.

- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you wish to format then press **Enter**.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Use this MAP to resolve the following problem:

• IOA detected device error (URC 9001)

Step 3337-1

A device configuration error has been detected. The configuration sectors on the device may be incompatible with the current I/O adapter.

Has the I/O adapter been replaced with a different type of I/O adapter, or have the devices been moved from a different type of I/O adapter to this one recently?

NO Go to "Step 3337-2" on page 86.

YES Go to "Step 3337-3" on page 86.

Step 3337-2

Contact your service support organization.

Exit this procedure.

Step 3337–3

Identify the affected disks by examining the error log and the **Display Hardware Status** screen. For further details, see "Viewing array status" on page 31.

Go to "Step 3337-4" on page 86.

Step 3337-4

If the I/O Adapter has been replaced by a different type of I/O Adapter, reinstall the original adapter.

Go to "Step 3337–5" on page 86.

Step 3337-5

If the disks involved have been moved from a different type of I/O Adapter to this one, return them to their original I/O Adapter.

Go to "Step 3337–6" on page 86.

Step 3337-6



Attention: The next step will cause data loss on the disks involved. If the data on these disks is important, perform back up procedures now.

Delete the disk arrays. For further details, see "Deleting an IBM SAS RAID disk array" on page 35.

Go to "Step 3337–7" on page 86.

Step 3337–7

Restore the initial hardware configuration that caused the error.

Go to <u>"Step 3337–8" on page 86</u>.

Step 3337-8

Create new disk arrays, then restore the saved data. For further details, see <u>"Creating an IBM SAS RAID</u> disk array" on page 33.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Use this MAP to resolve the following problem:

• Multiple controllers connected in an invalid configuration (URC 9073) for a 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 cards for a list of the supported adapters and their attributes.
 - Adapters have different write cache sizes.
 - One adapter is not supported by the Linux operating system.
 - 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 that does not have the same support.
 - Adapters connected for multi-initiator and high availability are not operating in the same dual initiator configuration. For example, both are not set to the default value or both are not set to the JBOD HA single path value.
 - 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 function.
 - One adapter, of a connected pair of adapters, is not operating under the Linux operating system. Connected adapters must both be controlled by the Linux operating system. Additionally, both adapters must be in the same logical partition if one adapter is an auxiliary cache adapter.
- An adapter is CCIN 572A but has a part number of either 44V4266 or 44V4404 (feature code 5900) that does not support multi-initiator and high availability.
- Adapters connected for multi-initiator and high availability are not cabled correctly. Each type of high availability configuration requires specific cables to be used in a supported manner.

Step 3340-1

Determine which of the possible causes apply to the current configuration and take the appropriate actions to correct the problem. If this action 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 perform the Verifying a repair procedure.

MAP 3341

Use this MAP to resolve the following problem:

Multiple controllers not capable of similar functions or not controlling the same set of devices (URC 9074) for a PCIe controller

Step 3341-1

Contact your service support organization.

MAP 3342

Use this MAP to resolve the following problem:

• Configuration error; incorrect connection between cascaded enclosure (URC 4010) for a PCIe controller

Step 3342-1

Incorrect SAS fabric connections. Contact your service provider.

Use this MAP to resolve the following problem:

• Configuration error; incorrect connection between cascaded enclosure (URC 4010) for a PCIe controller

Step 3342-1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3343

Use this MAP to resolve the following problem:

• Configuration error; connections exceed controller design limits (URC 4020) for a PCIe controller

Step 3343–1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3344

Use this MAP to resolve the following problems:

- Configuration error, incorrect multipath connection (URC 4030) for a PCIe controller
- Configuration error, incorrect multipath connection between controller and enclosure detected (URC 4030) for a PCIe controller

The possible causes follow:

• Incorrect cabling to device enclosure.



Attention: Ensure that the YO-cable, YI-cable, or X-cable is routed along the right side of the rack frame (as viewed from the rear) when connecting the cable to a disk expansion drawer. Examine 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 adapter 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.



Attention: Replacing RAID adapters is not recommended without assistance from your hardware service support organization when SAS fabric problems exist. 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 when SAS fabric problems exist.

Step 3344–1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3345

Use this MAP to resolve the following problem:

• Unsupported enclosure function detected (URC 4110) for a PCIe controller

The possible causes follow:

- Device enclosure or adapter microcode levels are not up to date
- Unsupported type of device enclosure or device

Step 3345-1

Ensure device enclosure or adapter microcode levels are up to date. If this does not correct the problem, contact your service provider.

MAP 3346

Use this MAP to resolve the following problem:

• Configuration error; incomplete multipath connection between enclosures and device detected (URC 4041) for a PCIe controller

The possible cause follows:

• 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.



Attention: Removing functioning disks in a disk array is not recommended without assistance from your Hardware Service Support organization. A disk array may become degraded or failed if functioning disks are removed and additional problems may be created.

Step 3346-1

Ensure device enclosure and SAS disks are properly plugged in their slots. If this does not correct the problem, contact your service provider.

MAP 3347

Use this MAP to resolve the following problem:

• Multiple controllers not capable of similar functions or not controlling the same set of devices (URC 9076) for a PCIe controller

Step 3347–1

Contact your service support organization.

MAP 3348

Use this MAP to resolve the following problem:

• Attached enclosure does not support required multipath function (URC 4050) for a PCIe controller

Step 3348-1

Contact your service provider.

MAP 3349

Use this map to resolve the following problem:

• Incomplete multipath connection between controller and remote controller (URC 9075) for a PCIe controller

Step 3349-1

Contact your service provider.

MAP 3350

Use the following to perform SAS fabric problem isolation for a 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 bus interface logic integrated onto the system boards and use a pluggable RAID Enablement Card (a non-PCI form factor card) for these SAS buses. For these configurations, replacement of the RAID Enablement Card is unlikely to solve a SAS fabric-related problem because the SAS interface logic is on the system board.



Attention: Replacing RAID adapters is not recommended without assistance from your service support organization when SAS fabric problems exist. Because the adapter may contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing an adapter when SAS fabric problems exist.



Attention: Removing functioning disks in a disk array is not recommended without assistance from your service support organization. A disk array may become *Degraded* or *Failed* if functioning disks are removed. Also, additional problems may be created.

Identify the SAS fabric on which the problem is occurring by examining the error log entry.

Go to <u>"Step 3350–2" on page 90</u>.

Step 3350-2

Have changes been made to the SAS configuration recently?

NO Go to "Step 3350-5" on page 91.

YES Go to "Step 3350-3" on page 90.

Step 3350-3

Check for the following problems:

- Cabling problems such as configurations that exceed the maximum cable lengths
- Ensure the SAS configuration does not have multi-initiators (for example, set up for a high-availability configuration)

Note: Multi-initiator support is not provided at this time.

For more details about supported SAS cabling, refer to *RS/6000 pSeries Adapters, Devices, and Cable Information for Multiple Bus Systems*.

Did you find a problem?

NO Go to "Step 3350-5" on page 91.

YES Go to "Step 3350–4" on page 90.

Step 3350-4

- 1. Power off the system or logical partition.
- 2. Correct the problem.
- 3. Power on the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric-related failure occur?

NO Go to <u>"Step 3350–14"</u> on page 92.

YES Go to "Step 3350-5" on page 91.

Step 3350-5

Determine if any of the disk arrays on the adapter are in an *Degraded* state. For details, see <u>"Viewing array</u> status" on page 31.

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

NO Go to "Step 3350-7" on page 91.

YES Go to "Step 3350–6" on page 91.

Step 3350-6

- 1. Identify the failed disks by first finding disk arrays with a state of *Degraded*, then finding disks on those arrays with a state of *Failed*.
- 2. Remove the failed disks from each Degraded disk array. For details, see "Physical disks" on page 56.
- 3. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric related failure occur?

NO Go to "Step 3350-14" on page 92.

YES Go to "Step 3350-7" on page 91.

Step 3350-7

Are there any non-essential removable media devices (such as Tape, CDROM, and DVDROM) on the SAS fabric?

```
NO Go to <u>"Step 3350–10" on page 91</u>.
```

```
YES Go to <u>"Step 3350–8" on page 91</u>.
```

Step 3350-8

- 1. Power off the system or logical partition.
- 2. Remove one of the non-essential removable media devices.
- 3. Power on the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric related failure occur?

```
NO Go to "Step 3350-9" on page 91.
```

```
YES Go to "Step 3350-7" on page 91.
```

Step 3350-9

The last removable media device removed from the SAS fabric may be the cause of the SAS fabric problems. Follow the repair procedures for that device.

Go to "Step 3350–14" on page 92.

Step 3350-10

Are there any non-essential disks that are not disk array members (such as 512 or 4096 byte per sector *JBOD* disks, *Hot Spare* disks, or *Advanced Function* disks) on the SAS fabric?

NO Go to "Step 3350–13" on page 92.

Step 3350-11

- 1. Remove one of the non-essential disk devices. For details, see "Physical disks" on page 56.
- 2. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric related failure occur?

NO Go to "Step 3350–12" on page 92.

```
YES Go to "Step 3350–10" on page 91.
```

Step 3350-12

The last disk removed from the SAS fabric may be the cause of the SAS fabric problems. Follow the repair procedures for that device.

Go to "Step 3350–14" on page 92.

Step 3350-13

Contact your service support organization.

Step 3350-14

- 1. Reinstall any good devices that were removed during the course of this MAP.
- 2. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.
- 3. Take action on any other non-SAS fabric related errors if they exist.

MAP 3351

Use the following procedure to determine what other field replaceable units (FRUs) besides a disk might need to be replaced in order to solve a problem.

You are sent here when an Advanced Function disk, a physical disk in 528 or 4224 bytes per sector format, was identified as the primary FRU to replace in order to resolve a problem. However, if replacing the disk did not resolve the problem, then other FRUs might need to be replaced.

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 PCIe bus interface logic integrated onto the system boards and use a pluggable RAID Enablement Card (a non-PCI form factor card) for these SAS/PCIe busses. For these configurations, replacement of the RAID Enablement Card is unlikely to solve a SAS fabric related problem since the SAS interface logic is on the system board.



Attention: Replacing RAID adapters is not recommended without assistance from your service support organization when SAS fabric problems exist. Because the adapter may contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing a adapter when SAS fabric problems exist.



Attention: Removing functioning disks in a disk array is not recommended without assistance from your service support organization. A disk array may become *Degraded* or *Failed* if functioning disks are removed. Also, additional problems may be created.

Step 3351-1

Identify the SAS fabric on which the problem is occurring by examining the error log entry.

Go to "Step 3351–2" on page 93.

Step 3351–2

While the error persists, replace the components of the failing SAS fabric in the following order.

- 1. Cable (if present)
- 2. Adapter (if SAS interface logic is on the adapter) or system board (if SAS interface logic is on the system board)
- 3. DASD backplane (if present)

To replace a component and see if the problem was corrected, do the following:

- 1. Power off the system or logical partition
- 2. Replace a component listed above
- 3. Power on the system or logical partition.
- 4. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3352

Use this MAP to resolve the following problems:

- Device bus fabric error (URC 4100) for a PCIe controller
- Temporary device bus fabric error (URC 4101) for a 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 PCIe bus interface logic integrated onto the system boards and use a pluggable RAID Enablement Card (a non-PCI form factor card) for these SAS/PCIe buses. 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.



Attention: Replacing RAID adapters is not recommended without assistance from your service provider when SAS fabric problems exist. Because the adapter may contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing a adapter when SAS fabric problems exist.



Attention: Removing functioning disks in a disk array is not recommended without assistance from your service provider. A disk array may become *Degraded* or *Failed* if functioning disks are removed and additional problems may be created.

Step 3352–1

Contact your service provider.

Use this map to resolve the following problem:

• Multipath redundancy level got worse (URC 4060) for a 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.

Note: The failed connection was previously working, and may have already recovered.

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 PCIe bus interface logic integrated onto the system boards and use a pluggable RAID Enablement Card (a non-PCI form factor card) for these SAS/PCI-X/PCIe buses. 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.



Attention: Replacing RAID adapters is not recommended without assistance from your service provider when SAS fabric problems exist. Because the adapter may contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing a adapter when SAS fabric problems exist.



Attention: Removing functioning disks in a disk array is not recommended without assistance from your service provider. A disk array may become *Degraded* or *Failed* if functioning disks are removed and additional problems may be created.

Step 3353–1

Contact your service provider.

MAP 3390

The problem that occurred is uncommon or complex to resolve. Information must be gathered and assistance must be obtained from your service support organization.

The possible causes for 9002 are:

• One or more SAS devices were moved from a PCIe3 controller to a PCIe controller. If the device was moved from a PCIe3 controller to a 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 PCIe3 controller or if the devices are formatted on the PCIe controller.

Step 3390-1

Make a copy of the entire /var/log/messages and /var/log/boot.msg files.

Go to <u>"Step 3390–2</u>" on page 94.

Step 3390-2

Collect the current disk array configuration. For details, see "Viewing device status" on page 29.

Go to "Step 3390-3" on page 95.
Step 3390-3

Collect any **ipr** dump files that may be applicable to the problem. They will be located in **/var/log**/. Go to "Step 3390–4" on page 95

Step 3390-4

Contact your service support organization.

MAP 3410

Use this MAP to resolve the following problems:

- Disk unit not supported at its physical location (URC 9025) for a PCIe3 controller
- Array no longer protected due to missing or failed disk unit (URC 9030) for a PCIe3 controller
- Array protection temporarily suspended (URC 9031) for a PCIe3 controller
- Disk array is degraded due to missing or failed disk (URC 9032) for a PCIe3 controller

Step 3410–1

Identify the disk array by examining the error log and the Display Disk Array Status screen. For information regarding accessing the Display Disk Array Status screen, see <u>"Viewing array status" on page 31</u>.

Go to <u>"Step 3410-2" on page 95</u>

Step 3410-2

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

NO Go to "Step 3410-3" on page 95.

YES Go to "Step 3410-4" on page 95.

Step 3410-3

The affected disk array must have a status of either *Rebuilt* or *Active* due to the use of a hot-spare disk. Create a new hot-spare disk for the disk array by completing the following steps:

- 1. Identify the failed disk by using the **Display Hardware Status** screen. For details, see <u>"Viewing array</u> status" on page 31. The failed disk has a *Failed* status.
- 2. Remove the failed disk and replace it with a new disk that is used as the hot spare. For details, see <u>"Physical disks" on page 56</u>.
- 3. The new disk must be formatted for advanced function to be used as a hot spare. If the new disk needs to be formatted, see "RAID and JBOD formats" on page 32.
- 4. Assign the new disk as a hot spare for the disk. For details, see <u>"Hot-spare disks" on page 36</u>.

When the problem is resolved, go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Step 3410-4

The failed disk must be replaced by completing the following steps:

- 1. Identify the failed disk by using the Display Hardware Status screen. For details, see <u>"Viewing array</u> status" on page 31. The failed disk has a *Failed* status.
- 2. Remove the failed disk, replace it with a new disk, and rebuild the disk unit data. For details, see <u>"Physical disks" on page 56</u>.

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.

When the problem is resolved, go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3411

Use this MAP to resolve the following problems:

- Array not functional due to present hardware configuration (URC 9020 / 9021 / 9022) for a PCIe3 controller
- One or more disk pairs are missing from an array (URC 9060) for a PCIe3 controller
- One or more disks are missing from an array (URC 9061 / 9062) for a PCIe3 controller

Step 3411–1

Identify the disks missing from the disk array by examining the error log and the **Display Hardware Status** screen. For details, see "Viewing array status" on page 31.

Go to "Step 3411–2" on page 96.

Step 3411-2

There are three possible ways to correct the problem. Perform only one of the following three options, listed in the order of preference:

- Locate the missing disks and install them in the correct physical locations in the system. Then, IPL the system or logical partition (it might be necessary to boot into Rescue mode), or reset the adapter by performing the following steps:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details, see "Viewing array status" on page 31.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.



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

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



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

1. Run the **iprconfig** utility by typing iprconfig.

- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you want to format then press **Enter**.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3412

Use this MAP to resolve the following problem:

• Array members not at required physical location (URC 9023) for a PCIe3 controller

Step 3412–1

Identify the disks that are not at their required physical locations by using the error log entry and the **Display Hardware Status** screen. For details, see <u>"Viewing device status</u>" on page 29.

Go to "Step 3412–2" on page 97.

Step 3412-2

There are three possible ways to correct the problem. Perform only one of the following three options, listed in the order of preference:

- Locate the missing disks and install them in the correct physical locations in the system. Then, IPL the system or logical partition (it might be necessary to boot into *Rescue* mode), or reset the adapter by performing the following steps:
 - 1. Find the scsi host number associated with the adapter by using the Display Hardware Status screen. For more details, see "Viewing device status" on page 29.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.



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

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



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

- 1. Run the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you want to format then press Enter.

When the problem is resolved, go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3413

Use this MAP to resolve the following problem:

• Array not functional due to present hardware configuration (URC 9027) for a PCIe3 controller

Step 3413–1

Identify the adapter and disks related to the error by examining the error log and the **Display Hardware Status** screen. For details, see "Viewing device status" on page 29.

Go to "Step 3413–2" on page 97.

Step 3413-2

Have the disks or adapter card been physically moved recently?

NO Contact your service support organization.

YES Go to "Step 3413-3" on page 97.

Step 3413–3

There are three possible ways to correct the problem. Perform only *one* of the following three options, listed in the order of preference:

- Restore the adapter and disks back to their original configuration. Then, IPL the system or logical partition (it might be necessary to boot into *Rescue* mode), or reset the adapter by performing the following steps:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details, see <u>"Viewing device status" on page 29</u>.

- 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- Delete the disk array. For details, see "Deleting an IBM SAS RAID disk array" on page 35.

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

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



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

1. Select Work with disk unit recovery.

- 2. Select Initialize and format disk unit.
- 3. Select the drives you want to format then press Enter.
- 4. Run the **iprconfig** utility by typing iprconfig.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3420

Use this MAP to resolve the following problem:

• Cache data associated with attached disks cannot be found (URC 9010) for a PCIe3 controller

Step 3420-1

Contact your service support organization.

MAP 3421

Use this MAP to resolve the following problems:

• IOA resources not available due to previous problems (URC 9054) for a PCIe3 controller

Step 3421–1

Perform the following steps:

- 1. Remove any new or replacement disks which are attached to the adapter.
- 2. Resolve the other errors which occurred at the same time as this error.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3430

Use this MAP to resolve the following problem:

• IOA does not support functions expected by devices (URC 9008) for a PCIe3 controller

The possible causes follow:

- The adapter or disks are 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 PCIe controller to a PCIe3 controller and the disks had one of the following attributes which is not supported by a PCIe3 controller:
 - The disks were used in a disk array with a stripe-unit size of 16 KB, 64 KB, or 512 KB (a PCIe3 controller supports only a stripe-unit size of 256 KB).

The disks were used in a RAID level 5 or 6 disk array which had disks added to it after it was initially created (a PCIe3 controller does not support adding disks to a previously created RAID level 5 or 6 disk array).

Step 3430-1

Identify the affected disks by examining the error log and the **Display Hardware Status** screen. For details, see <u>"Viewing device status</u>" on page 29.

Go to "Step 3430–2" on page 99.

Step 3430-2

Have the adapter card or disks been physically moved recently?

NO Contact your service support organization.

YES Go to "Step 3430-3" on page 99.

Step 3430–3

There are two possible ways to correct the problem. Perform only *one* of the following two options, listed in the order of preference:

- Restore the adapter and disks to their original configuration. Then, either IPL the system or logical partition (it might be necessary to boot into *Rescue* mode) or reset the adapter by performing the following steps:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details, see "Viewing device status" on page 29.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- Format the remaining members of the disk array, as follows:

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

- 1. Run the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you want to format then press Enter.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3431

Use this MAP to resolve the following problem: Required cache data cannot be located for one or more disks (URC 9050) for PCIe3 controllers.

Step 3431-1

Did you just exchange the adapter as the result of a failure?

NO Go to "Step 3431–2" on page 99.

YES Contact your hardware service provider.

Step 3431-2

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

- 1. View the error log and identify the affected disk
- 2. Go to "Step 3431-3" on page 100.

Step 3431–3

Have the adapter or disks been physically moved recently?

NO Contact your hardware service provider.

YES Go to "Step 3431–4" on page 100.

Step 3431-4

Is the data on the disks needed for this or any other system?

NO Go to <u>"Step 3431–6" on page 100.</u>

YES Go to "Step 3431-5" on page 100.

Step 3431–5

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.

Step 3431-6

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

1. Reclaim controller cache storage by performing the following steps:



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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select Work with disk unit recovery.
- c. Select Reclaim IOA cache storage.
- d. Confirm to proceed.
- 2. If the disks are members of a disk array, delete the disk array by completing the following steps:



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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select Work with disk array.
- c. Select Delete a disk array.
- d. From the listed disk arrays, select the disk array you want to delete, and press Enter.
- 3. Format the disks by completing the following steps:



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

- a. Type **iprconfig** to run the iprconfig utility.
- b. Select Work with disk arrays.
- c. Select Format device for RAID function.
- d. From the list of eligible disk units, choose the disks you want to format for advanced function and press **Enter**.

MAP 3432

Use this MAP to resolve the problem: Cache data exists for one or more missing or failed disks (URC 9051) for a PCIe3 controllers.

The problem can occur because of the following reasons:

- 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 3432–1

Identify the affected disks by examining the hardware error log. Complete the following steps to view the error log:

- 1. View the error log and identify the affected disk.
- 2. Go to "Step 3432-2" on page 101.

Step 3432-2

Are there other disk or adapter errors that have occurred at approximately the same time as this error?

```
NO Go to <u>"Step 3432–3" on page 101.</u>
```

YES Go to <u>"Step 3432–6" on page 101.</u>

Step 3432–3

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 3432-7" on page 101.

YES Go to <u>"Step 3432–4" on page 101.</u>

Step 3432–4

Have the adapter card or disks been physically moved recently?

NO Contact your hardware service provider.

YES Go to "Step 3432–5" on page 101.

Step 3432–5

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.

Step 3432–6

Take action on the other errors that have occurred at the same time as this error.

Step 3432–7

Reclaim the Controller Cache Storage by performing the following steps:

Note: Data will be lost.

1. Type **iprconfig** to run the iprconfig utility.

- 2. Select Work with disk unit recovery.
- 3. Select Reclaim IOA cache storage.
- 4. Confirm to proceed.

MAP 3433

Use this MAP to resolve the following problems:

- Disk unit is modified after the last known status (URC 9090) for a PCIe3 controller
- Incorrect hardware configuration change is detected (URC 9091) for a PCIe3 controller

Step 3433–1

IPL the system or logical partition (it might be necessary to boot into *Rescue* mode), or reset the adapter by performing the following steps:

- 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For details, see <u>"Viewing device status" on page 29</u>.
- 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.

Resolve any new errors which surface.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems.*

MAP 3434

Use this MAP to resolve the following problem:

• Disk unit requires initialization before use (URC 9092) for a PCIe3 controller

The possible causes are:

- 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. For example, not using the **Device Concurrent Maintenance** screen in **iprconfig** when concurrently removing and installing disks (see <u>"Physical disks" on page 56</u>) or not performing a normal power down of the system before reconfiguring disks and adapters.
- Disk is member of a disk array, but was detected subsequent to the adapter being configured.
- Disk has multiple or complex configuration problems.

Step 3434–1

Identify the affected disks by examining the error log and the **Display Hardware Status** screen. For details, see <u>"Viewing device status</u>" on page 29.

Go to <u>"Step 3434–2" on page 102</u>.

Step 3434-2

Are there other disk or adapter errors that occurred at about the same time as this error?

NO Go to "Step 3434-4" on page 103.

YES Go to <u>"Step 3434–3" on page 102.</u>

Step 3434-3

Resolve the other errors that occurred at the same time as this error.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

Step 3434-4

Have the disks or adapter card been physically moved recently?

NO Go to <u>"Step 3434–5" on page 103.</u>

YES Go to "Step 3434-6" on page 103.

Step 3434-5

Is the data on the disks needed for this system or any other system?

NO Go to "Step 3434-7" on page 103.

YES Go to "Step 3434-6" on page 103.

Step 3434–6

There are three possible ways to correct this problem. Perform only one of the following three options:

- IPL the system or logical partition (it might be necessary to boot into *Rescue* mode), or reset the adapter by performing the following steps:
 - 1. Find the SCSI host number associated with the adapter by using the **Display Hardware Status** screen. For more details, see "Viewing device status" on page 29.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- Restore the adapter and disks back to their original configuration. Then, IPL the system or logical partition (it might be necessary to boot into *Rescue* mode), or reset the adapter by performing the following steps:
 - 1. Find the SCSI host number associated with the adapter by using the Display Hardware Status screen. For more details, see "Viewing device status" on page 29.
 - 2. Use the echo 1 > /sys/class/scsi_host/hostX/reset_host command to reset the adapter, where X is the SCSI host number from the previous step.
- · Remove the disks from this adapter

When the problem is resolved then go to MAP 0410: Repair Checkout, in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems.*

Step 3434-7

There are two possible ways to correct the problem. Perform only one of these options.

• Format the disks, as follows:



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

- 1. Run the **iprconfig** utility by typing iprconfig.
- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you want to format then press Enter.
- If the disks are members of a disk array, delete the disk array. See <u>"Deleting an IBM SAS RAID disk</u> array" on page 35.

Note: In some rare scenarios, deleting the disk array will not have any effect on a disk and the disk must be formatted instead.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3435

Use this MAP to resolve the following problem:

• Disk media format bad (URC FFF3) for a PCIe3 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 3435–1

Identify the affected disk by examining the error log and the **Display Hardware Status** screen. For details, see <u>"Viewing device status" on page 29</u>.

Go to "Step 3435-2" on page 104.

Step 3435-2

Format the disks, as follows:

Attention: All data on the disks will be lost.

1. Run the **iprconfig** utility by typing iprconfig.

- 2. Select Work with disk unit recovery.
- 3. Select Initialize and format disk unit.
- 4. Select the drives you want to format then press Enter.

When the problem is resolved then go to MAP 0410: Repair Checkout in *RS/6000 eServer pSeries Diagnostic Information for Multiple Bus Systems*.

MAP 3440

Use this MAP to resolve the following problem:

• Multiple controllers connected in an invalid configuration (URC 9073) for a PCIe3 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 cards for a list of the supported adapters and their attributes.
 - Adapters have different write cache sizes.
 - One adapter is not supported by the Linux operating system.
 - 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 that does not have the same support.
 - Adapters connected for multi-initiator and high availability are not operating in the same dual initiator configuration. For example, both are not set to the default value or both are not set to the JBOD HA single path value.
 - 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 function.
 - One adapter, of a connected pair of adapters, is not operating under the Linux operating system. Connected adapters must both be controlled by the Linux operating system. Additionally, both adapters must be in the same logical partition if one adapter is an auxiliary cache adapter.

- An adapter is CCIN 572A but has a part number of either 44V4266 or 44V4404 (feature code 5900) that does not support multi-initiator and high availability.
- Adapters connected for multi-initiator and high availability are not cabled correctly. Each type of high availability configuration requires specific cables to be used in a supported manner.

Step 3440-1

Determine which of the possible causes applies to the current configuration and take the appropriate actions to correct the problem. If this action 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 perform the Verifying a repair procedure.

MAP 3441

Use this MAP to resolve the following problem:

• Multiple controllers not capable of similar functions or controlling the same set of devices (URC 9074) for a PCIe3 controller

Step 3441-1

Contact your service support organization.

MAP 3442

Use this MAP to resolve the following problem:

Configuration error; incorrect connection between cascaded enclosure (URC 4010) for a PCIe3 controller

Step 3442-1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3443

Use this MAP to resolve the following problem:

• Configuration error; connections exceed controller design limits (URC 4020) for a PCIe3 controller

Step 3443-1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3444

Use this MAP to resolve the following problems:

- Configuration error, incorrect multipath connection (URC 4030) for a PCIe3 controller
- Configuration error, incorrect multipath connection between controller and enclosure detected (URC 4030) for a PCIe3 controller

The possible causes follow:

• Incorrect cabling to device enclosure.



Attention: Ensure that a YO-cable, YI-cable, or X-cable is routed along the right side of the rack frame (as viewed from the rear) when connecting the cable 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 adapter 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.



Attention: Do not replace the RAID adapters without assistance from your hardware service support organization when SAS fabric problems exist. 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 when SAS fabric problems exist.

Step 3444–1

Incorrect SAS fabric connections. Contact your service provider.

MAP 3445

Use this MAP to resolve the following problem:

• Unsupported enclosure function detected (URC 4110) for a PCIe3 controller

The possible causes follow:

- Device enclosure or adapter microcode levels are not up to date
- · Unsupported type of device enclosure or device

Step 3445-1

Ensure that device enclosure or adapter microcode levels are up to date. If this action does not correct the problem, contact your service provider.

MAP 3446

Use this MAP to resolve the following problem:

• Configuration error; incomplete multipath connection between enclosures and device detected (URC 4041) for a PCIe3 controller

The possible cause follows:

• 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.



Attention: Do not remove the functioning disks in a disk array 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 3446-1

Ensure that device enclosure and SAS disks are properly plugged in their slots. If this action does not correct the problem, contact your service provider.

MAP 3447

Use this MAP to resolve the following problem:

• Multiple controllers not capable of similar functions or controlling the same set of devices (URC 9076) for a PCIe3 controller

Step 3447–1

Contact your service support organization.

MAP 3448

Use this MAP to resolve the following problem:

• Attached enclosure does not support required multipath function (URC 4050) for a PCIe3 controller

Step 3448-1

Contact your service provider.

MAP 3449

Use this map to resolve the following problem:

• Incomplete multipath connection between controller and remote controller (URC 9075) for a PCIe3 controller

Note: This problem is not expected to occur for a PCIe3 controller.

Step 3449–1

Proceed to "MAP 3490" on page 111

MAP 3450

Use the following to perform SAS fabric problem isolation for a PCIe3 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 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:

- Do not replace the RAID adapters without assistance from your service support organization when SAS fabric problems exist. Because the adapter may contain non-volatile 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.
- Do not remove the functioning disks in a disk array without assistance from your service support organization. A disk array might become *Degraded* or *Failed* if functioning disks are removed. Also, additional problems might be created.

Identify the SAS fabric on which the problem is occurring by examining the error log entry.

Go to "Step 3450-2" on page 107.

Step 3450-2

Have changes been made to the SAS configuration recently?

NO Go to "Step 3450-5" on page 108.

Step 3450–3

Check for the following problems:

- Cabling problems such as configurations that exceed the maximum cable lengths
- Ensure that the SAS configuration does not have multi-initiators (for example, set up for a high-availability configuration)

Note: Multi-initiator support is not provided at this time.

For details about supported SAS cabling, see RS/6000 pSeries Adapters, Devices, and Cable Information for Multiple Bus Systems.

Did you find a problem?

NO Go to <u>"Step 3450–5" on page 108</u>.

YES Go to "Step 3450-4" on page 108.

Step 3450-4

- 1. Power off the system or logical partition.
- 2. Correct the problem.
- 3. Power on the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric-related failure occur?

NO Go to "Step 3450–14" on page 109.

YES Go to "Step 3450-5" on page 108.

Step 3450-5

Determine if any of the disk arrays on the adapter are in a *Degraded* state. For details, see <u>"Viewing array</u> status" on page 31.

Does any disk array have a Degraded state?

NO Go to "Step 3450-7" on page 108.

YES Go to <u>"Step 3450–6" on page 108.</u>

Step 3450–6

- 1. Identify the failed disks by first finding disk arrays with a *Degraded* state, then finding disks on those arrays with a state of *Failed*.
- 2. Remove the failed disks from each *Degraded* disk array. For details, see "Physical disks" on page 56.
- 3. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric-related failure occur?

NO Go to <u>"Step 3450–14" on page 109.</u>

YES Go to "Step 3450-7" on page 108.

Step 3450-7

Are there any nonessential removable media devices (such as Tape, CD, and DVD) on the SAS fabric?

NO Go to <u>"Step 3450–10" on page 109</u>.

YES Go to <u>"Step 3450–8" on page 109</u>.

Step 3450-8

- 1. Power off the system or logical partition.
- 2. Remove one of the nonessential removable media devices.
- 3. Power on the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric-related failure occur?

NO Go to "Step 3450-9" on page 109.

YES Go to <u>"Step 3450–7" on page 108</u>.

Step 3450-9

The last removable media device removed from the SAS fabric might be the cause of the SAS fabric problems. Follow the repair procedures for that device.

Go to <u>"Step 3450–14" on page 109</u>.

Step 3450-10

Are there any non essential disks that are not disk array members (such as 512 or 4096 byte per sector *JBOD* disks, *Hot Spare* disks, or *Advanced Function* disks) on the SAS fabric?

NO Go to "Step 3450-13" on page 109.

YES Go to "Step 3450-11" on page 109.

Step 3450-11

- 1. Remove one of the nonessential disk devices. For details, see "Physical disks" on page 56.
- 2. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.

Did a SAS fabric-related failure occur?

NO Go to "Step 3450-12" on page 109.

YES Go to <u>"Step 3450–10" on page 109</u>.

Step 3450-12

The last disk removed from the SAS fabric might be the cause of the SAS fabric problems. Follow the repair procedures for that device.

Go to "Step 3450-14" on page 109.

Step 3450-13

Contact your service support organization.

Step 3450-14

- 1. Reinstall any good devices that were removed during this MAP.
- 2. Reboot the system or logical partition. If you cannot power on normally, boot to *Rescue* mode. Examine the error log.
- 3. Resolve any other non-SAS fabric-related errors if they exist.

MAP 3452

Use this MAP to resolve the following problems:

• Device bus fabric error (URC 4100) for a PCIe3 controller

• Temporary device bus fabric error (URC 4101) for a PCIe3 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 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.



Attention:

- Do not replace the RAID adapters without assistance from your service provider when SAS fabric problems exist. Because the adapter might contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing an adapter when SAS fabric problems exist.
- Do not remove the functioning disks in a disk array without assistance from your service provider. A disk array might become *Degraded* or *Failed* if functioning disks are removed and additional problems might be created.

Step 3453-1

Contact your service provider.

MAP 3453

Use this map to resolve the following problem:

• Multipath redundancy level got worse (URC 4060) for a PCIe3 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: The failed connection was previously working, and might already be recovered.

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.



Attention:

• Do not replace the RAID adapters without assistance from your service provider when SAS fabric problems exist. Because the adapter might contain non-volatile write cache data and configuration data for the attached disk arrays, additional problems can be created by replacing an adapter when SAS fabric problems exist.

• Do not remove the functioning disks in a disk array without assistance from your service provider. A disk array might become *Degraded* or *Failed* if functioning disks are removed and additional problems might be created.

Step 3453–1

Contact your service provider.

MAP 3454

Use this map to resolve the following problem: Device bus fabric performance degradation (URC 4102) for a PCIe3 controller **Note:** This problem is not common for a PCIe3 controller.

Step 3454–1

Proceed to <u>"MAP 3490" on page 111</u>

MAP 3460

Use this map to resolve the following problems:

- Scatter list tag / sequence number error (URC 4170) for a PCIe3 controller
- Recovered scatter list tag / sequence number error (URC 4171) for a PCIe3 controller

Note: This problem is not common for a PCIe3 controller.

Step 3460–1

Proceed to "MAP 3490" on page 111

MAP 3461

Use this map to resolve the following problems:

- Configuration error, cable VPD cannot be read (URC 4120) for a PCIe3 controller
- Configuration error, required cable is missing (URC 4121) for a PCIe3 controller

Note: This problem is not common for a PCIe3 controller.

Step 3461–1

Proceed to <u>"MAP 3490" on page 111</u>

MAP 3490

The problem that occurred is uncommon or complex to resolve. Information must be gathered and assistance obtained from your service support organization.

Step 3490–1

Make a copy of the entire /var/log/messages and /var/log/boot.msg files. Go to "Step 3490-2" on page 111.

Step 3490-2

Collect the current disk array configuration. For details, see <u>"Viewing device status" on page 29</u> Go to "Step 3490–3" on page 111.

Step 3490-3

Collect any **ipr** dump files that might be applicable to the problem. The files are located at /var/log/.

Go to "Step 3490–4" on page 112.

Step 3490-4

Contact your service support organization.

MAP 3495

Use this MAP to resolve the following problem:

• I/O adapter (IOA) exceeded maximum operating temperature (URC 4080) for a PCIe3 controller.

Step 3495–1

Determine which of the following items are the cause for the exceeded maximum operating temperature and take the appropriate actions. If this action does not correct the error, contact your hardware service provider.

- The adapter is installed in an unsupported system. Verify that the adapter is supported on this system by checking the Adapter information by feature code for the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9009-41A, 9009-41G, 9009-42A, 9009-42G, 9040-MR9, 9080-M9S, 9223-22H, 9223-22S, 9223-42H, 9223-42S system and EMX0 PCIe3 expansion drawers.
- The adapter is installed in an unsupported slot location within the system unit or an I/O enclosure. Verify that the adapter is located in a supported slot location. See the 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. Verify any system specific requirements for this adapter by checking the Adapter information by feature code for the 5105-22E, 9008-22L, 9009-22A, 9009-22G, 9009-41A, 9009-41G, 9009-42A, 9009-42G, 9040-MR9, 9080-M9S, 9223-22H, 9223-22S, 9223-42H, 9223-42S system and EMX0 PCIe3 expansion drawers.
- Fan failures or obstructions affecting the cooling of the adapter.

Note: The adapter that is logging this error continues to log this error while it remains at a temperature higher than the maximum operating temperature or every 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 perform the Verifying a repair procedure.

MAP 3496

Use this MAP to resolve the following problem:

SAS adapter hardware configuration error (SRN nnnn-4086) for a PCIe3 controller.

Step 3496-1

This error indicates to configuration problems of an adapter hardware. To obtain the reason or description for this failure, you must find the formatted error information in the Linux error log.

To view the hardware error log and to determine the reason for the failure, complete the following steps:

- 1. Follow the steps in Examining the hardware error log and return here.
- 2. Select the hardware error log you want to view. In the hardware error log, the **Detail Data** section contains the reason for failure and the values for **Adapter Resource, Resource Description, Physical Location** fields.

Step 3496-2

Determine the reason for failure and information about the adapter that is shown in the error log, and perform the action listed for the reason in the following table:

| Table 18. Incorrect configuration reason for failure | | | | |
|---|---|---|---|--|
| Reason for failure | Description | Action | Adapter on which to perform the action | |
| Incorrect adapter and device backplane combination. | There is an unsupported adapter and an internal device backplane combination. The adapter type (feature) is not supported to be connected to the type of internal device backplane installed in the system. | Verify the type of adapters that are connected to the internal device backplane and also verify the type of internal device backplane installed in the system. Refer to the <u>SAS</u> <u>subsystem</u> topic to verify the correct configuration for your system type and model. | The adapter type and location indicated in the error log. | |
| Storage controller located in an incorrect slot. | An adapter that is connected to the internal device backplane is either located in an incorrect PCI slot or the adapter is not the correct feature code to support the functions needed when connected to the internal device backplane. | Verify the feature of adapters that are connected to the internal device backplane and the slot/s in which they are located. Either install the correct adapter feature code or move the adapter to the correct supported PCI slot. Refer to the <u>SAS</u> <u>subsystem</u> topic to verify the correct configuration and adapter feature required for your system type and model. | The adapter type and location indicated in the error log. | |
| SAS cable inserted into incorrect adapter connector that is labeled as T#. | The AZ or AZ4 SAS cable from the internal Device Backplane is plugged into to an incorrect adapter connector as indicated by the T# label. | By using the connection labels on each end of the SAS cable, verify that each end is connected to the correct adapter slot and adapter connector. Refer to the <u>SAS subsystem</u> topic to verify the correct configuration for your system type and model. | The adapter that logged the error. | |
| Other | | Contact your hardware service provider. | | |

If you have verified that the configuration is valid, consider replacing the cable that attaches the adapters to the internal device backplane.

When the problem is resolved, see the removal and replacement procedures topic for the system unit on which you are working and perform the <u>Verifying a repair</u> procedure.

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Korea Notice

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

People's Republic of China Notice



Russia Notice

ВНИМАНИЕ! Настоящее изделие относится к классу А. В жилых помещениях оно может создавать радиопомехи, для снижения которых необходимы дополнительные меры

Taiwan Notice

警告使用者: 此為甲類資訊技術設備, 於居住環境中使用時,可 能會造成射頻擾動,在此 種情況下,使用者會被要 求採取某些適當的對策。

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

United States Federal Communications Commission (FCC) Notice

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. Proper cables and connectors are available from IBM-authorized dealers. 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.

Responsible Party: International Business Machines Corporation New Orchard Road Armonk, NY 10504 Contact for FCC compliance information only: fccinfo@us.ibm.com

Class B Notices

The following Class B statements apply to features designated as electromagnetic compatibility (EMC) Class B in the feature installation information.

When attaching a monitor to the equipment, you must use the designated monitor cable and any interference suppression devices supplied with the monitor.

Canada Notice

CAN ICES-3 (B)/NMB-3(B)

European Community and Morocco Notice

This product is in conformity with the protection requirements of Directive 2014/30/EU of the European Parliament and of the Council on the harmonization 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.

German Notice

Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse B EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2014/30/EU zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaatenund hält die Grenzwerte der EN 55022/ EN 55032 Klasse B 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.

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 2014/30/EU in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC Richtlinie 2014/30/EU) 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 Relations Europe, Abteilung M456 IBM-Allee 1, 71139 Ehningen, Germany Tel: +49 (0) 800 225 5426 email: HalloIBM@de.ibm.com

Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55032 Klasse B

Japan Electronics and Information Technology Industries Association (JEITA) Notice

(一社)電子情報技術産業協会 高調波電流抑制対策実施 要領に基づく定格入力電力値: Knowledge Centerの各製品の 仕様ページ参照

This statement applies to products less than or equal to 20 A per phase.

高調波電流規格 JIS C 61000-3-2 適合品

This statement applies to products greater than 20 A, single phase.

 高調波電流規格 JIS C 61000-3-2 準用品
 本装置は、「高圧又は特別高圧で受電する需要家の高調波抑制対 策ガイドライン」対象機器(高調波発生機器)です。
 ・回路分類 : 6(単相、PFC回路付)
 ・換算係数 : 0

This statement applies to products greater than 20 A per phase, three-phase.

高調波電流規格 JIS C 61000-3-2 準用品
本装置は、「高圧又は特別高圧で受電する需要家の高調波抑制対策ガイドライン」対象機器(高調波発生機器)です。
・回路分類 : 5 (3相、PFC回路付)
・換算係数 : 0

Japan Voluntary Control Council for Interference (VCCI) Notice

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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

Taiwan Notice

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

United States Federal Communications Commission (FCC) Notice

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 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.

Responsible Party:

International Business Machines Corporation New Orchard Road Armonk, New York 10504 Contact for FCC compliance information only: fccinfo@us.ibm.com

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