



# Intel<sup>®</sup> Server RAID Controller U2-1 (SRCU21)

## *Technical Product Specification*

*Document number 245412-002*



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**Enterprise Platforms Group**

## *Revision History*

Date	Revision	Modifications
10/1999	1.0	Initial Release
2/2000	1.1	Added section 6.2.1 containing Server Boards products supported by the SRCU21. First availability.
6/2000	1.2	Updated to reflect SRCU21 latest software kit update
6/2000	1.3	Updated Legal Notice and section 3.1 OS Support

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# 1. Overview

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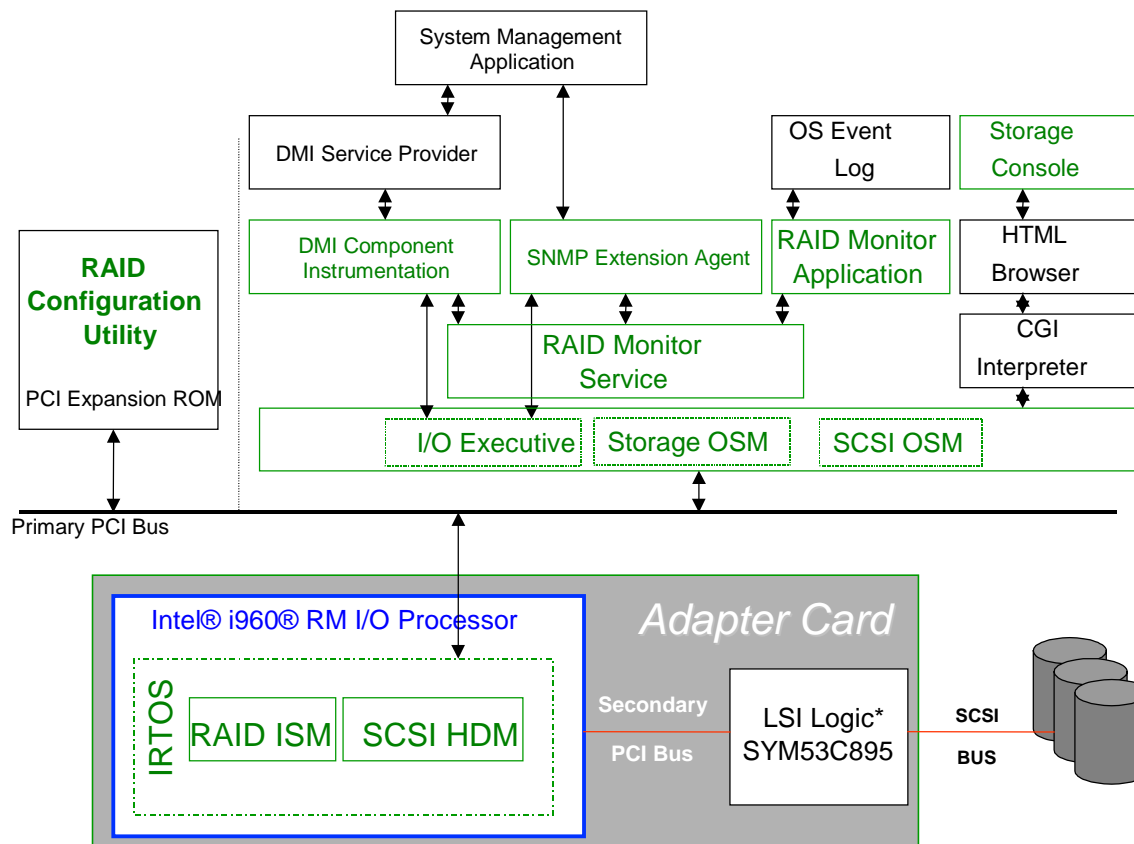
This technical product specification covers the following

- Intel® Server RAID Controller U2-1 (PCI RAID Adapter Card)
- Intel® Integrated RAID software (RAID Software for the Adapter)

The Intel Server RAID Controller U2-1 (SRCU21) is a single-channel Ultra 2 SCSI RAID PCI adapter card. It utilizes the Intel® i960® RM Intelligent I/O processor, the LSI Logic\* SYM53C895 SCSI controller, and the Intel Integrated RAID software.

The Intel Server RAID Controller U2-1 was designed as an accessory for the following Intel server board products only: L440GX+ and C440GX+. Intel Corporation has performed exhaustive validation of the Intel Server RAID Controller U2-1 with these products. The Intel Server RAID Controller U2-1 is the first of a family of RAID products from Intel that will execute the Intel Integrated RAID software.

## 2. Intel Integrated RAID Architecture



**Note:** Items colored in green, or light text if printing in Black and White, are part of the Intel Integrated RAID software.

The Intel Server RAID Controller U2-1 is based upon the I<sub>2</sub>O 1.5 specification, an open architecture that is independent of the operating system, processor platform, and system I/O bus. This split-driver model approach allows OS vendors to produce a single driver for each I<sub>2</sub>O class of device. Likewise, the hardware vendor has to produce only one version of their driver that works for any OS that supports I<sub>2</sub>O.

The Intel Server RAID Controller U2-1 houses the LSI Logic SYM53C895 HDM and the Intel Integrated RAID ISM in firmware on the adapter. The adapter can be utilized in the supported operating systems, each of which has implemented the appropriate Block Storage Class and SCSI OSM's. The Intel Server RAID Controller U2-1 includes a PCI Expansion ROM that is accessible during system boot. Additionally, Intel Integrated RAID software provides other operating system specific utilities, such as the RAID Monitor service.

## 3. RAID Features

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### 3.1 OS Support

Intel Integrated RAID is designed to work with the following operating systems families:

- Windows NT\* 4.0, Server Editions
- Novell NetWare\* 4.2
- Novell NetWare 5.0
- SCO UnixWare\* 7.1

Consult the Supported Hardware/Operating Systems document for a current list of supported operating systems (including version and service pack information).

### 3.2 Supported RAID levels

- RAID 0 – The minimum number of drives supported is 1, maximum is 15.
- RAID 1 – The minimum number of drives supported is 2, maximum is 15.
- RAID 5 – The minimum number of drives supported is 3, maximum is 15.
- RAID 10 – Minimum number of drives supported is 3, maximum is 15.

**Note:** RAID 10 is a combination of RAID 0 and RAID1 and is not user selectable. It is a function of how the Intel Integrated RAID writes data on RAID 1 arrays with 3 or more disks configured.

### 3.3 Hot Plug Drive Support

Remove and replace SCA disk drives while I/O activity is taking place on the same SCSI bus, provided that both the hard drive and backplane fully support hot-swap.

### 3.4 Online Array Expansion

The ability to add new drives to an existing array while server is on-line. New space is immediately available for volume creation without requiring a reboot.

### 3.5 Online Volume Migration

Change a volume's RAID level or stripe size while the server is online and the volume is in-use.

### 3.6 AutoDeclare Spare

When an existing array is in a degraded state, adding a *new* disk that is of the same size or larger than the failed disk will automatically become a spare for the degraded array, and rebuild will then automatically commence. If the new disk is smaller than the failed disk, it will not be marked as a spare and volume will remain degraded.

- With a SAF-TE enclosure, a bus scan occurs automatically when the drive is inserted. No manual intervention is required.
- When an enclosure without SAF-TE support is used, a reboot or bus scan is required for the Auto Declare Spare feature to commence.
- A new drive may be different or same SCSI ID as the failed drive.

### 3.7 Array Roaming

Array Roaming allows the user the ability to move a complete array to another system (with drives in any SCSI ID slot) and still preserve RAID configuration and user data on that array. Intel Integrated RAID firmware versions do not have to be the same on both systems (firmware updates are backwards compatible). The array being moved must be connected while the destination server is offline.

### 3.8 Background Initialization / Instant Availability

All necessary initializations take place in the background after submitting a RAID volume creation request. The new volumes are available immediately, protecting newly written data and creating parity data concurrently. Supported operating systems will provide instant access to newly created arrays without requiring a system reboot. Volume initialization is not impacted by system reboots, so the server administrators may shutdown the server and volume initialization will continue once the server restarts.

### 3.9 Pass-Thru Disks

One or more SCSI disks attached to the RAID adapter may be presented to the operating system individually and not as part of a RAID volume.

### 3.10 Adjustable Rebuild Priority

Rebuilding a degraded volume incurs a load on the IOP, the secondary PCI bus, the volume itself, and the SCSI bus. Intel Integrated RAID software allows the user to select the rebuild priority (low, medium, high) to balance volume access and rebuild tasks appropriately. The priority determines the ratio of IOP cycles dedicated to the volume rebuild process versus the number of cycles available to receive requests from the OSM. Like volume initialization, a system reboot will not require the rebuild process to restart from the beginning.



### 3.11 Global Hot-Spares

A global hot spare is a spare physical disk drive that has been marked as a hot spare and therefore is not passed through to the host OS and is not a member of an array. The hot spare automatically takes the place of a failed disk in a RAID 1, 5, or 10 volume. Multiple Global Hot Spares are allowed. The user is warned if a selected hot-spare disk does not have at least the same capacity as the drives in the array.

## 4. Hardware Components

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### 4.1 PCI 2.2 Compliant

The Intel® Server RAID Controller U2-1 is PCI 2.2 compliant. In addition, it is designed to function properly in PCI 2.1 compliant motherboards that provide a 3.3v power source to the PCI connector.

### 4.2 Intel® i960® RM Intelligent I/O Processor

The Intel Server RAID Controller U2-1 features the Intel i960® RM processor. The core processor, PCI-to-PCI bridge, Memory Controller, and Application Accelerator Unit are particularly useful in RAID applications. For more information on the Intel i960 RM processor, visit <http://developer.intel.com/design/iio/index.htm>.

#### 4.2.1 Intel I960 Core

The 80960JT core processor runs at 100Mhz on the i960 RM internal 32-bit bus. Among other features, it contains a 128-bit register bus, 16Kbyte two-way instruction cache, 4Kbyte direct-mapped data cache, 1Kbyte zero wait state data RAM, and single clock execution of most instructions.

#### 4.2.2 PCI-to-PCI Bridge Unit

The PCI-to-PCI bridge features fully independent PCI bus operation with independent clocks, dedicated data queues, 32-bit 33Mhz PCI bus support, and 64-bit Dual Address Cycle addressing.

#### 4.2.3 Memory Controller

The Memory Controller provides direct control of memory systems external to the i960 RM, including SDRAM, ROM, and Flash. It features programmable chip selects, a wait state generator, ECC single-bit correction and double-bit error detection. The memory controller operates at 66Mhz.

#### 4.2.4 Application Accelerator Unit

The Application Accelerator Unit (AAU) provides low-latency, high-throughput data transfer between the AAU and the 80960 local memory. In addition to performing data transfers, the AAU can perform XOR calculations on up to eight 128-byte pieces of data in one clock cycle. XOR calculations are used in every RAID 5 write transaction, and on every read transaction from a degraded RAID 5 volume.

### 4.3 Other Adapter Card Components

In addition to the Intel i960 RM processor, the Intel Server RAID Controller U2-1 utilizes the following major components.

### 4.3.1 LSI Logic\* SYM53C895 SCSI Controller

The SYM53C895 is a PCI Single-Channel Ultra 2 SCSI controller. It supports one SCSI channel with up to 80 MB/sec data transfer rate. It supports Low Voltage Differential (LVD) and Single-Ended (SE) SCSI devices. It also features 160Mhz internal operation, extra large 816 byte DMA FIFO, and LVDlink Universal Low Voltage Differential transceivers.

### 4.3.2 Intel® Smart 3 FlashFile™ Flash Memory

This 3.3v, 16Mbit flash memory chip is used to store the RAID firmware. This non-volatile storage can be address by the host processor for firmware updates.

### 4.3.3 ECC SDRAM

The Intel Server RAID Controller U2-1 provides an interface for 32Mbytes up to 128Mbytes of 3.3v PC-100 ECC unbuffered CAS 2 latency 168-pin DIMM SDRAM, only. It is connected directly to the memory controller interface bus of the IOP, and serves as storage for the executable code transferred from the flash. It also serves as cache during RAID transactions and has three cache modes. Cache mode selection takes immediate effect while the server is online. Single-bit ECC error correction is provided by the Memory Controller.

- The **Downstream Write-Through Cache** mode uses cache memory to buffer write data until written to disk. This does not allow a read from cache following a write. All read commands get data from disk to ensure data consistency. This is not a user selectable option, however it is enabled any time that a Write-Back cache mode has not been selected.
- The **Sequential Write-Back Cache** mode is selectable on a per volume basis and gives a successful write reply as soon as the write data is moved to the RAID controller cache. The actual write to disk will occur some time later. Only data from disk writes that are determined to be sequential are cached.
- The **Full Write-Back** mode is selectable on a per volume basis and gives a successful write reply as soon as the write data is moved to the RAID controller cache. Data from all disk writes is cached.

Please refer to the Validation section of this document for a list of memory modules that have been validated with the Intel Server RAID Controller U2-1.

### 4.3.4 Diagnostic Features

The 80960 RM I/O processor JTAG signals are brought to a 16-pin connector. This connector is used to interface the card to a JTAG emulator for design or manufacturing debugging.

The Intel Server RAID Controller U2-1 provides a SCSI activity LED to indicate traffic on the SCSI channel. A second LED indicates the status of the IOP.

Additionally, jumper pins are provided which allow the adapter to be booted with the IOP in reset mode, allowing host access to recover non-functional firmware.

## 5. Intel Integrated RAID Software Features

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### 5.1 Storage Console

The Intel Integrated RAID Storage Console is an HTML interface to the RAID subsystem. This is the primary tool for configuring multiple RAID volumes, monitoring volume status, managing disk drives, viewing enclosure, and all other configuration aspects of the RAID subsystem.

A CGI application interfaces with the Storage OSM and I<sub>2</sub>O Executive Service on the operating system. A CGI interpreter and HTML browser are required. Novell NetWare and SCO Unixware provide these applications. Windows NT 4.0 requires an add-on product for the CGI interpreter, such as Microsoft Internet Information Server. HTML browser requirements for Windows NT 4.0 are Microsoft Internet Explorer 4.0 or higher, or Netscape Navigator 4.0 or higher.

#### 5.1.1 Remote Management

Since Storage Console is an HTML-based application, remote connections to the server are supported. The host operating system or web service is responsible for ensuring proper remote user credentials are met when connecting remotely. The OSM still provides local security as described under the security heading below.

#### 5.1.2 RAID Features

Storage Console is the primary RAID configuration utility. All RAID features are accessible with this utility with the exception of selecting the boot device. These include:

- Array Expansion
- Volume Creation, Deletion
- Volume RAID level and Stripe Size migration
- Cache mode selection
- Enclosure state monitoring (for SAF-TE enclosures)
- Disk drive state selection (mark offline, format, pass-thru, hot spare, etc...)
- OEM/IHV support contact information
- Bus Scan
- Reset Configuration
- Multiple views from disk, volume and array perspectives
- Storage Console name customization for OEM/IHV branding
- Administrative level privileges required to execute

#### 5.1.3 Ease-of-Use

Due to the HTML format of the Storage Console utility, Intel Integrated RAID software has a consistent look and feel across multiple OS platforms. Additionally, the typical volume creation process recommends the proper volume RAID level and hot spare selection based upon available disks. Online help is provided, as well as highly visible notifications when the user is attempting to perform an action that might compromise their data integrity.

### 5.1.4 Security

The OSM ensures that proper local authentication has been satisfied prior to allowing the user to access the RAID subsystem via Storage Console. The following administrative level requirements must be met:

- Windows NT Server 4.0 – Administrators group
- Novell NetWare – Administrator
- SCO UnixWare – root

## 5.2 RAID Configuration Utility

The RAID Configuration Utility (RCU) is a PCI Expansion ROM, accessible at boot time by hitting CNTL-C while the host system is booting. The intention of the RCU is to give the system administrator the ability to create the initial RAID volume upon which an OS will be installed, without the need of any additional diskettes.

### 5.2.1 Boot Time Status

While the system is booting, the Intel Server RAID Controller reference card firmware will initialize. The name of the selected boot volume will be displayed on the console, as well as error messages such as disk failures, absence of all SCSI disks, and firmware or memory failures.

### 5.2.2 RAID Features

Should the user enter the RCU by selecting CNTL-C at boot time, they will have access to the following RAID features:

- Status display showing number and status of connected disks and volumes.
- The ability to create the first RAID volume. All available disks will be utilized, the highest possible RAID level will be chosen, the option to select a hot spare will be presented, the option to select the new drive as the boot volume will be presented.
- Disk pass-thru selection
- Disk drive formatting
- Boot device (volume or Pass-thru disk) selection
- Volume deletion
- Reset Configuration
- Online help
- RCU is limited to utilizing the first eight disks on the RAID controller for volume creation, deletion, boot device select, and status display features. RCU is limited to a combination of eight volumes and pass-thru disks for volume deletion, boot device select, and status display features.

### 5.3 RAID Monitor Service

The RAID Monitor Service detects events from the RAID subsystem and provides a local console alert. An entry is made in the appropriate event logging mechanism for the host OS. RAID Monitor provides the following features:

- Windows NT Server – utilizes Event Log, displays alert using local dialogue box
- Novell NetWare – creates /sys/system/raid.log, displays System Console alert
- SCO UnixWare – utilizes /usr/adm/syslog, can be configured to send administrative mail
- Can launch Storage Console upon events
- Event polling frequency adjustable from 5 to 60 seconds.
- Captures volume, disk and battery events.

### 5.4 Flash Update and Recovery Utilities

The Intel® Integrated RAID software provides flash utilities to perform adapter card firmware updates or recover from firmware corruption. Both utilities are directly executable from the Intel Integrated RAID software CD's ROM-DOS boot menu, as well as through diskettes that can be created from the HTML Launcher interface. When executing from the Intel Integrated RAID software CD ROM-DOS boot menu, the user may elect to update firmware from the CD itself, or from floppy disk.

### 5.5 ROM-DOS Menu

The Intel® Integrated RAID software CD-ROM contains a bootable ROM-DOS menu that provides access to the following features:

- Flash Update and Recovery Utilities
- RAID Troubleshooting (IOPSETUP) – This utility loads the DOS Interface Transport utility that lets an administrator access the software running on the IOP. Through this utility, the administrator or OEM/IHV technical support can fully access the RAID subsystem without having to rely on a bootable host OS.
- Diskette Creation Feature – The ROM-DOS boot menu provides the ability to create Flash Update and Recovery, OS installation, firmware, and RAID Troubleshooting Diskettes.

### 5.6 HTML Launcher

When the Intel® Integrated RAID software CD is inserted into a Windows NT 4.0 system, the operating system's autorun feature will bring up an HTML launcher using the host operating systems registered web browser. The HTML Launcher provides the following features:

- HTML-based for easy OEM/IHV customization.
- Frame for OEM/IHV logo
- Diskette creation feature
- RAID Software Suite installation for Windows NT 4.0
- Hewlett-Packard OpenView\* 5.02 Console Integration Setup
- User's Manual in HTML format
- Link for release notes

## 5.7 Flash Update Utility – Manufacturing Version

FUU-MFG is a command line driven RAID configuration utility that is useful for setting up RAID volumes during the OEM or IHV's manufacturing or system integration process. Up to six SCSI disks may be configured with FUU-MFG.

## 5.8 Software Installation

### 5.8.1 Windows NT Server 4.0

Installation of the I<sub>2</sub>O OSM's, Raid Monitor Service and Application, a link to Storage Console, and the PDF version of the User's Manual (collectively termed RAID Software Suite) is performed through an InstallShield\* setup program. The setup program detects for the correct OS and Service Pack versions, the existence of Microsoft Internet Information Server\*, proper user authentication, and notifies the user of additional requirements should they elect to install DMI Component Instrumentation and SNMP integration. An uninstall utility is also provided, which provides the option to uninstall the RAID Software Suite and I<sub>2</sub>O OSM's separately.

In addition to the RAID Software Suite, integration with Hewlett-Packard's OpenView\* 5.02 system management software package is provided. An Intel Integrated RAID node is created, providing access to Storage Console and event alerts within the HP OpenView framework.

### 5.8.2 Novell NetWare 4.2 and 5.0

Installation of the RAID Software Suite is done by first creating a diskette from the ROM-DOS boot menu or from the HTML launcher (running from a Win32 machine). The typical Novell methodology for installing hardware drivers and software is followed.

### 5.8.3 SCO UnixWare 7.1

Installation of the RAID Software Suite is done by first creating two driver diskettes from the ROM-DOS boot menu or from the HTML launcher (running from a Win32 machine). The remainder of the software is installed by executing an installation script from the Intel Integrated RAID software CD-ROM.

## 6. Certifications and Supported Technologies

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### 6.1 OS Certifications

The Intel Server RAID Controller U2-1 has been tested against the following OS certification and labeling programs. The SRCU21 has been certified under all of these programs.

- Microsoft Windows Hardware Quality Labs (WHQL) version 9.1
- Novell “Yes, Tested and Approved” – Storage Access Services (DISKIT 2.9e)
- SCO UnixWare “Works with SCO”

### 6.2 Supported Technologies

#### 6.2.1 Server Boards

Consult the Supported Hardware/Operating Systems document for a current list of supported Intel platforms.

Or visit the Intel Server RAID Controller support web site for the most current list of supported Intel platforms, at <http://support.intel.com/support/motherboards/server/srcu31>.

#### 6.2.2 I<sub>2</sub>O 1.5 Core Implementation

The Intel Integrated RAID software is a core implementation of the I<sub>2</sub>O 1.5 specification. The software uses I<sub>2</sub>O messages to communicate between the RAID ISM, the SCSI controller HDM, and external OSM's. The Intel i960 RM processor executes these modules within the Wind River Systems, Inc. IxWorks\* I<sub>2</sub>O Real-Time Operating System. This provides the possibility for the IOP to be utilized for other I<sub>2</sub>O compatible uses, particularly in systems where the OEM/IHV has elected to integrate the IOP onto the motherboard. For additional information on I<sub>2</sub>O, refer to the I<sub>2</sub>O Special Interest Group web site at <http://www.i2osig.org>.

#### 6.2.3 SAF-TE 1.0

The Intel Server RAID Controller U2-1 supports SAF-TE enclosures adhering to the SAF-TE 1.0 specification.

Depending on the SAF-TE features supported by the enclosure, the following enclosure properties are supported by the Intel Integrated RAID software, and are displayed on the Enclosure page within Storage Console:

- Number of fans installed and their status
- Number of power supplies and their status
- Number of temperature sensors, the temperature readings, and their status
- Temperature out of range
- Door lock and speaker status
- Number of device slots, their SCSI ID's and status



The Intel Integrated RAID software will prepare device slots on SAF-TE enclosures by powering down and powering up the slot appropriately upon drive removal and insertion. No vendor specific commands are supported. Please refer to the Validation section of this document for a list of validated SAF-TE enclosures. For additional information on SAF-TE, refer to <http://www.safte.org>.

#### **6.2.4 SMART**

For those drives that provide SMART support, the Intel Integrated RAID software's RAID ISM stores the information the disk drive generates when a SMART event occurs. These events are accessible from the Physical Disk page of Storage Console.

## 7. Scalability

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The Intel Server RAID Controller U2-1 has been validated according to the following limitations. Please see <http://support.intel.com/> for a list of validated hard disk drives and enclosures.

### 7.1 Enclosure Validation Limits

The Intel Server RAID Controller U2-1 can control 1 enclosure. This includes SAF-TE and non-SAF-TE enclosures.

### 7.2 Disk Drive Validation Limits

The Intel Server RAID Controller U2-1 has been validated with a total of 15 disks. The maximum number of drives per channel is 15 (assuming Ultra 2 LVD drives).

### 7.3 Array Validation Limits

The Intel Server RAID Controller U2-1 has been validated with up to eight arrays. An array is a group of disks that contain one or more RAID volumes.

### 7.4 Volume Validation Limits

The Intel Server RAID Controller U2-1 has been validated with up to 8 volumes.

### 7.5 Non-Block Storage Devices

The Intel Server RAID Controller U2-1 supports Non-Block Storage Devices except for CD-ROMs via the SCSI OSM (RAID transactions are controlled by the Storage OSM). The SRCU21 has been validated with up to 2 Non-Block Storage Devices (excluding SAF-TE Enclosure Processors). CD-ROM Devices attached to the SRCU21 are not supported.

### 7.6 Multiple SRCU21 Adapters

The Intel Server RAID Controller U2-1 has been validated with up to two adapters in the same system.

## Glossary

API	Application Programmer Interface
BSP	Board Support Package (for the IxWorks* IRTOS)
CGI	Common Gateway Interface (used by the HTML Browser)
DIT	DOS Interface Transport
DLL	Dynamic Linked Library
DOS	Generic term to reference either MS-DOS* or ROM-DOS*
DDM	Device Driver Module (I <sub>2</sub> O term referring to an HDM or ISM)
DMI	Desktop Management Interface
FRU	Flash Update/Recovery Utility
HTML	Hyper Text Markup Language
HDM	Hardware Device Module (I <sub>2</sub> O hardware dependent device driver module, specific to the SCSI controller)
I <sub>2</sub> O*	Intelligent I/O (architecture)
IOP	I/O Processor, the Intel® i960® RM
IRTS	I <sub>2</sub> O Real Time Operating System
ISM	Intermediate Service Module (I <sub>2</sub> O hardware independent DDM, performs a specific function such as RAID)
LVD	Low Voltage Differential SCSI
OSM	OS Service Module (I <sub>2</sub> O DDM that interfaces the host OS to the I <sub>2</sub> O message layer)
RAID	Redundant Array of Independent Disks
SAF-TE	SCSI Accessed Fault Tolerant Enclosure
SCA	Single Connector Attachment (80-pin SCSI connector on hot-swappable Ultra 2 LVD hard disks)
SCSI	Small Computer Systems Interface
SMART	Self-Monitoring, Analysis, and Reporting Technology (disk drive error reporting feature)
SNMP	Simple Network Monitoring Protocol
XROM	PCI Expansion ROM (BIOS utility accessed at boot)