Intel® Server RAID Controller U3-1 (SRCU31)

Technical Product Specification

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Enterprise Platforms Group

Revision History

Date	Revision	Modifications
6/2000	Rev 1.0	Initial Release
8/2000	Rev 1.1	Updated OS terminonlogy in section 3.1

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1. Overview

The Intel® Server RAID Controller U3-1 (SRCU31) is a single-channel Ultra 160 SCSI RAID PCI adapter card. It utilizes the Intel® i960® RN Intelligent I/O processor, the LSI Logic SYM53C1010* SCSI controller, and Intel® Integrated RAID software.

The Intel Server RAID Controller U3-1 was designed as an accessory for several Intel server board products and Intel Corporation has performed exhaustive validation of the Intel Server RAID Controller U3-1 with these products. Visit the Intel Server RAID Controller support web site at http://support.intel.com/support/motherboards/server/srcu31 for the most current list of supported Intel platforms.

2. Intel® Integrated RAID Architecture

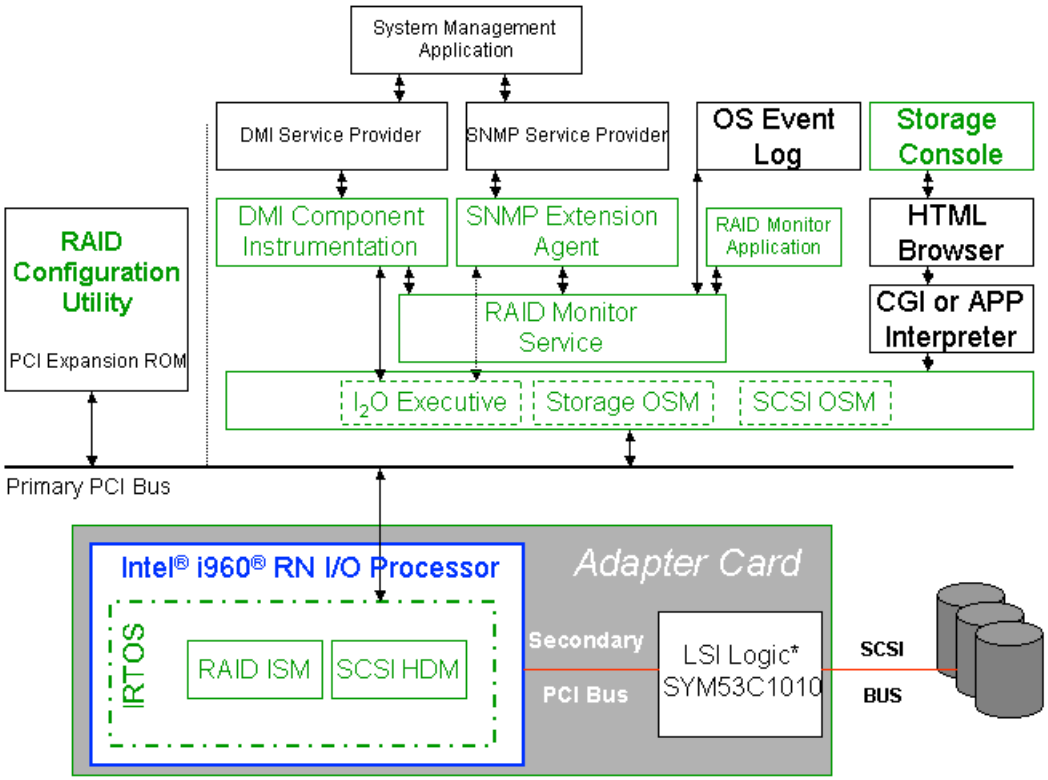

Figure 1 – Intel Integrated RAID Architecture

The Intel Server RAID Controller U3-1 is based upon the I_20 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_20 class of device. Likewise, the hardware vendor has to produce only one version of their driver that works for any OS that supports I_20.

The Intel Server RAID Controller U3-1 houses the LSI Logic SYM53C1010 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 U3-1 includes a PCI Expansion ROM-based BIOS utility that is accessible during system boot. Additionally, Intel Integrated RAID software provides other operating system specific utilities, such as the RAID Monitor service

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3. RAID Features

3.1 OS Support

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

- Windows NT* Server 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 2.
- 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 Array Roaming

Array Roaming provides the user with the ability to move a complete array to another system and still preserve the RAID configuration and user data on that array. This may be done while the server is online if the drives and disk enclosure support hot-plug capabilities. The drives are not required to have the same SCSI ID in the target system that they did in the original. This feature is available because of the two bus scanning modes of this product:

- The ***Destructive* bus scan** option is the default behavior and assumes that any drive found during the bus scan is blank.
- The ***Merge Mode* bus scan** option detects existing Intel Integrated RAID compatible configuration information on disks being scanned. By connecting a complete array of hot-plug capable disks and then subsequently scanning those disks with the *Merge*

Mode bus scan option, an existing array can be added to a server while the server remains online.

3.6 Online Volume Migration

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

3.7 AutoDeclare Spare

When an existing array is in 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 have the same or a different SCSI ID as the failed drive which it replaces.

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 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

4.1 64-bit, 33Mhz PCI 2.2 Interface

The Intel Server RAID Controller U3-1 has a 64-bit PCI connector and it designed to perform 64-bit, 33Mhz PCI slot. The adapter is also supported in 32-bit, 33Mhz PCI slots. The Intel Server RAID Controller U3-1 is PCI 2.2 compliant.

4.2 Intel i960® RN Intelligent I/O Processor

The Intel Server RAID Controller U3-1 features the Intel i960® RN 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 RN 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 RN 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, 64-bit and 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 RN, 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 RN processor, the Intel Server RAID Controller U3-1 utilizes the following major components.

4.3.1 LSI Logic* SYM53C1010 SCSI Controller

The SYM53C1010 is a PCI Dual-Channel Ultra 160 SCSI controller. On the Intel Server RAID Controller U3-1, one SCSI channel with up to 160 MB/sec data transfer rate is supported.

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 Cache Memory

The Intel Server RAID Controller U3-1 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. The IOP memory controller provides single-bit ECC error correction.

- 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 U3-1.

4.3.4 Diagnostic Features

The Intel Server RAID Controller Reference Design provides a SCSI activity LED to indicate traffic on the SCSI channels.

Additionally, a jumper pin is provided which allows the adapter to be booted with the IOP in reset mode, allowing host access to recover non-functional firmware. An LED is provided that activates when the IOP is in reset mode.

5. Intel Integrated RAID Software Features

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.

5.1.1 Local Storage Console and Remote Storage Console

The Storage Console application is available in two formats under Windows NT. Remote Storage Console utilizes a CGI application to provide an interface between the web browser and the OSM's. For Windows NT, Internet Information Server is utilized to host the required CGI application. When Remote Storage Console is installed on a server, the RAID subsystem can be managed remotely by another intranet client. Remote Storage Console requires Internet Explorer 4.0 or higher or Netscape 4.0 or higher.

Local Storage Console differs because it utilizes a custom plug-in for the HTML browser as the interface to the OSM's. Local Storage Console is useful when remote management of the RAID subsystem is not required. Local Storage Console requires Internet Explorer 4.0 or higher.

Note: With the exception of Remote Management, both versions of Storage Console provide equal functionality.

5.1.2 Remote Management

Since Remote 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.

5.1.3 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…)
- Bus Scan Mode Selection and Execution
- Reset Configuration
- Multiple views from disk, volume and array perspectives
- Administrative level privileges required to execute

Note: The *Boot Device Selection* feature is not available from Storage Console. Use the RAID Configuration Utility (RCU) to change the default boot device.

5.1.4 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.

5.1.5 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-based utility, accessible at boot time by hitting CTRL-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. The adapter firmware version also displays on the screen during initialization.

5.2.2 RAID Features

RCU offers the following 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 user will be guided through the volume creation process and intelligent values will be recommended for the highest possible RAID level, the option to select a hot spare, and the option to select the new volume as the boot device.
- Disk pass-thru selection
- Disk drive formatting
- Boot device (volume or Pass-thru disk) selection
- Volume deletion
- Reset Configuration
- Online help

5.3 Advanced RAID Configuration Utility

The Advanced RAID Configuration Utility is a ROM-DOS-based, text-only version of the Local Storage Console utility. Available from bootable CD-ROM or floppy disk, this utility is useful for accessing advanced RAID configuration options (such as multiple volume creation, caching selections etc.) prior to having a fully operational operating system on the server.

5.4 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. Can launch Storage Console upon event.
- Novell NetWare – creates /sys/system/raid.log, displays System Console alert
- SCO UnixWare – utilizes /usr/adm/syslog, can be configured to send administrative mail
- All: Event polling frequency adjustable from 5 to 60 seconds. Capture volume, disk, and battery events.

5.5 Firmware 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 ROM-DOS Menu or the CD ROM's Win32* Splash Screen. When executing from the Intel Integrated RAID software CD ROM-DOS boot menu, the user may elect to update firmware from the CD or from floppy disk.

5.6 Floppy Diskette Creation

The Intel Integrated RAID software CD-ROM provides the ability to create floppy disks from either the ROM-DOS boot menu, or the Win32 Splash Screen. The following diskettes can be created:

- Windows NT, Netware, and UnixWare installation drivers
- Firmware Recovery/Update Utility
- Advanced RAID Configuration Utility
- Production Firmware image file

5.7 ROM-DOS Menu

The Intel Integrated RAID software CD-ROM contains a bootable ROM-DOS* menu that provides the ability to execute the following features directly from the bootable CD-ROM:

- Firmware Update and Recovery Utilities
- Advanced RAID Configuration Utility –Through this utility, the administrator can fully access the RAID subsystem without having to rely on a bootable host OS.
- Floppy Diskette Creation Feature – See section Floppy Diskette Creation
- User's Manual – a DOS PDF file and viewer are provided so that the user may view the User's Manual from the bootable CD-ROM.

5.8 Software Installation

5.8.1 Windows NT Server 4.0

Installation of the I_20 OSM's, Raid Monitor Service and Application, a link to Storage Console, and the HTML and PDF versions 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_20 OSM's separately.

In addition to the RAID Software Suite, integration with Hewlett-Packards 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 CD Splash Screen (running from a Win32 machine). The typical Novell methodology for installing hardware drivers and software is followed using the *nwconfig* utility.

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 CD Splash Screen (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

6.1 OS Certifications

The Intel Server RAID Controller U3-1 has been tested against the following OS certification and labeling programs. The SRCU31 has been certified under all of these programs.

- Microsoft Windows Hardware Quality Labs (WHQL) – HCT version 9.5
- Novell "Yes, Tested and Approved" – Storage Access Services (TESTKIT 3.0)
- 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_20 1.5 Core Implementation

The Intel Integrated RAID software is a core implementation of the I_20 1.5 specification. The software uses I_20 messages to communicate between the RAID ISM, the SCSI controller HDM, and external OSM's. The Intel i960 RN processor executes these modules within the Wind River Systems, Inc. IxWorks* I_20 Real-Time Operating System. This provides the possibility for the IOP to be utilized for other I_20 compatible uses, particularly in systems where the OEM/IHV has elected to integrate the IOP onto the motherboard. For additional information on I_20, refer to the I_20 Special Interest Group web site at http://www.i2osig.org.

6.2.3 SAF-TE 1.0

The Intel Server RAID Controller U3-1 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
- 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 S.M.A.R.T.

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 Specifications

The Intel Server RAID Controller U3-1 has been validated according to the following limitations. Please see http://support.intel.com/support/motherboards/server/srcu31 for a list of validated hard disk drives and enclosures.

7.1 Enclosure Validation Limits

The Intel Server RAID Controller U3-1 can control one enclosure. This includes SAF-TE and non-SAF-TE enclosures.

7.2 Disk Drive Validation Limits

The Intel Server RAID Controller U3-1 has been validated with a total of 15 disks. The maximum number of drives per channel is 15 (assuming Ultra 160 LVD drives).

7.3 Array Validation Limits

The Intel Server RAID Controller U3-1 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 U3-1 has been validated with up to eight volumes.

7.5 Non-Block Storage Devices

The SRCU31 does not support Non-Block Storage Devices except for SAF-TE enclosure processors. CD-ROM devices attached to the SRCU31 are not supported. The SRCU31 supports disk drive type devices (Direct-access devices in the SCSI-2 specification) and SAF-TE enclosure processors (processor devices in the SCSI-2 specification). No other SCSI-2 device classes have been validated or are supported.

7.6 Multiple SRCU31 Adapters

The Intel Server RAID Controller U3-1 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_2O 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_20 hardware dependent device driver module, specific to the SCSI controller)
I_2O*	Intelligent I/O (architecture)
IOP	I/O Processor, the Intel® i960® RN
IRTOS	I_2O Real Time Operating System
ISM	Intermediate Service Module (I_20 hardware independent DDM, performs a specific function such as RAID)
LVD	Low Voltage Differential SCSI
OSM	OS Service Module (I_20 DDM that interfaces the host OS to the I_20 message layer)
RAID	Redundant Array of Independent Disks
RCU	RAID Configuration Utility – BIOS-based RAID configuration tool. See XROM.
SAF-TE	SCSI Accessed Fault Tolerant Enclosure
SCA	Single Connector Attachment (80-pin SCSI connector on hot-swappable Ultra 3 LVD hard disks)
SCSI	Small Computer Systems Interface
S.M.A.R.T.	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)