Sun StorEdge™ 6320 System

Just the Facts

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Important Note
Common Information Model (CIM)

To ease interoperability with leading IT management utilities and simplify storage management, the Sun StorEdge™ 6320 system uses the following CIM, open standards-based terms for common storage and data management functions.

Old Term		CIM Term
Volume	—>	Storage Pool
Slice	—>	Volume
LUN	—>	Volume
Adminstrative Domain	—>	Storage Array
Partner Pair	—>	Storage Array
Enclosure	—>	Tray (Storage Module)
Expansion Unit	—>	Expansion Unit
Controller Tray	—>	Controller Tray

Tray (Storage Module)

Refers to a single Storage Module, or Tray. Multiple 'trays' connected together, are a Storage Array. Trays with a controller are Controller Trays. Trays without a controller are Expansion Units.

Controller Tray

A tray with an installed RAID controller. The controller tray is the smallest possible storage array configuration. The architecture integrates disks, data cache, hardware RAID, power, cooling, uninterrupted power supply (UPS), diagnostic capabilities, and administration into a versatile, standalone component. The controller tray includes external connections to a data host (or switch), and to a management network.

Expansion Unit

A Tray without an installed RAID controller.

Storage Array

A storage system containing multiple disk drives, designed to provide performance, high availability, serviceability, or other benefits. Disk arrays may provide mechanisms to create virtual extents of volumes, such as RAID groups. The physical and logical elements of the storage array are managed as a group. A storage array must contain at least one tray with a RAID controller.

Sun StorEdge 6020

The Sun StorEdge 6020 is a storage array that is specifically designed for the Sun StorEdge 6320 system. With dual controller-based storage modules, these arrays provide high availability expansion and immense configuration flexibility for the Sun StorEdge 6320 series.

Extent

A set of disk blocks with logical consecutive addresses. Extents can be smaller or larger than physical disks. Storage arrays with RAID allow you to combine several disks together into a larger "virtual disk".

Although the underlying disks are separate extents, the resulting virtual disk is addressed from zero up to its new size; so this virtual disk is also an extent. A volume manager provides a similar capability of merging extents from disks into larger virtual extents.

Storage Pool

A collection of storage extents with the same “quality of service”.

Storage Policy

A Sun midrange storage array or system configuration that is uniquely tuned for specific application workloads.

Volume

A volume is a virtual disk into which a file system, a DBMS, or an application can place data. A volume may be a single physical disk or a virtual disk mapped from one or more underlying extents. Applications that use volumes do not need to be aware of their underlying physical structure. Software or firmware handles the mapping of virtual addresses to physical addresses.

Quality of Service

“Quality of service” refers to the objective of obtaining a desired level of system behavior achieved by using tunable system factors within a storage array. RAID level, number of hot spare disks, multi-path access, and disk speed are some of the factors that influence quality of service. Quality of service can be very specific—for example, no single point of failure, must use RAID 1, must have at least one hot spare—or very general—for example, any storage will do.

Positioning

Introduction

Figure 2. Sun StorEdge™ 6320 system

Designed to help meet the challenges of your most dynamic multi-application deployments, the Sun StorEdge 6320 system delivers the market-focused flexibility, availability, and performance of an advanced modular architecture with integrated system-wide manageability. The massively scalable, easy-to-deploy system grows right along with your business, scaling incrementally from 500GB to 45TB to meet your changing needs, and its balanced approach to storage ensures that capacity and performance scale seamlessly to meet application requirements. The Sun StorEdge 6320 system is easily managed from a single console, and it provides high levels of data availability through high redundancy, proactive fault detection, automatic call-home, and remote diagnostics. Which helps you reduce overhead, increase utilization, and reduce management cost and complexity.

Availability

Key schedule dates for the Sun StorEdge 6320 system:

• Sun Product Introduction (Presto)	April 1, 2003
• WebDesk	April 1, 2003
• Public Announcement	April 8, 2003
• Revenue Release (RR)	April 21, 2003
• General Availability (GA)	April 30, 2003 (7 and 14 drives/tray configurations) May 30, 2003 (8 to 13 drives/tray configurations)

Key Features

- Storage Policies for simplified provision to a wide variety of application workloads
- Immense scalability from 504 GB to over 45 TB
- Comprehensive system and data management from a central console using standards-based, open management software
- SAN-wide management utility for simplified, unified control over large SAN deployments
- Data copy and replication services that facilitate data continuance solutions providing increased data availability, disaster recovery, and parallel data sharing by multiple applications
- Continuous proactive remote system monitoring and support
- System Access Panel provide unified, easy access to all system components
- Drive tray depopulation, supporting a minimum of seven drives/tray (50 percent of total capacity)
- Mix-and-match 2x2, 2x4, or 2x6 arrays within the system to match performance and capacity to the application
- Fibre Channel architecture front to back
- Each drive tray includes up to fourteen 1-inch drives, dual hot-swap/redundant power/cooling units with integrated redundant UPS batteries, four hot-swap/redundant electrically independent cooling fans, and hot-swap/redundant interconnect cards for predictable linear performance scalability and consistent availability
- Each controller tray includes a highly reliable hardware RAID controller featuring 1-GB data cache with ECC protection, one 2-Gb fibre channel (FC) host inteface, two 1-Gb FC drive channels per RAID controller, and UPS protected controller cache
- Online controller firmware upgrades
- Sun Indicator Standard (SIS)-compliant LEDs on the front of every array assist users in locating specific arrays in a heavily populated data center
- High-performance, modular loop card serial communication protocol offers failure fencing and fault containment in case of hardware failure
- Quick-snap locking mechanisms for easy insertion/extraction of disks and other FRUs
- Bi-directional, dual-ported FC-AL disk drives include the following capacities:

  - 36 GB at 15,000 rpm
  - 73 GB at 10,000 rpm
  - 146 GB at 10,000 rpm
- Embedded Storage Service Processor with:
  - 24x7 monitoring of components in the storage system[1]
  - Configuration of Sun StorEdge 6020 arrays and Fibre Channel switches through SNIA-compliant software
  - Upgrades to firmware/software in the Storage Service Processor itself
  - Diagnostic tools to troubleshoot problems
- Sun StorEdge Remote Response capability—phone-home, remote support capability
- Maximum of 10 disk trays in the base cabinet
- Maximum of 22 disk trays using both the base and expansion cabinets
- Each Storage Moduile (tray) is pre-configured with one RAID 5 storage pool and one hot-spare
- Volume masking offers volume security and controls access to volumes
- Multi-volume functionality supports up to 320 volumes (using just the base cabinet) and up to 704 volumes (using two cabinets)
- Minimum volume size is 10 MB, maximum size is 2 TB
- Hardware-based RAID 5, RAID 1 (1+0), or RAID 0
- Remote power cycle and reboot to remotely and securely power on and off the entire storage system.
- Automated firmware/software upgrades for all components
- Shared phone line for up to eight Sun StorEdge 6320 systems
- Automated analysis of patch baselines for availability of latest patch baseline
- Integrated switch and switchless configurations are available
- Support for enhanced security using integrated firewall/router
- Data-in-place investment protection
- Heterogenous Interoperability, including the Solaris™ Operating Environment, Microsoft Windows 2000/NT, Linux, IBM-AIX, and HP/UX

[1]This does not occur unless Sun StorEdge Remote Response (SSRR) service is enabled. Details around SSRR can be found later in this document.

Features and Benefits

Features	Benefits
• Storage Policies	• Simplifies storage provisioning and reduces the time needed to tune an advanced storage architecture to specific application workloads
• Data services with Sun StorEdge Availability Suite 3.1 software	• Helps minimize disruption to on-line data processing • Keeps uptime to a maximum by allowing on-line processing to continue while backup processes occur • Accelerates new application development by testing with actual production data • Facilitates data sharing between numerous applications on heterogeneous platforms • Helps increase data accessibility under extreme and new situations
• SAN management with Sun StorEdge Enterprise Storage Manager 1.2 software	• Simplifies management of Sun Open SAN environments through a centralized management console • Helps improve reliability and availability of Sun Open SAN environments through SAN-wide expert-based health monitoring and management • Understands data path and SAN element relationships with Global Discovery; identifies and maps all Fibre Channel elements on Sun Open SAN
• Modular architecture	• Utilizes the storage infrastructure efficiently through virtually seamless, non-disruptive expansion • Enables businesses to easily right-size the storage architecture to the specific application requirements, matching storage costs to business value
• Data-in-place Investment Protection	• Helps extend the life and reduce the risk of obsolescence for critical storage resources
• Unified, System Access Panel	• Easy to access system panel that is pre-wired for maximum expansion • Reduces the opportunity for human error in wiring for various SAN deployments
• Depopulated tray support	• Provides a low entry price and greater levels of configuration flexibility
• Base cabinet holds up to 140 drives; base and expansion cabinets hold up to 308 drives	• High density packaging of the Sun StorEdge 6020 array allows for more storage capacity per floor tile
• One view, system-wide management utility	• Helps reduced day-to-day administrative costs and provides quick device configuration

Features	Benefits
• Support for up to 176 disparate hosts	• Allows many hosts to access the same storage for maximum utilization and greater ROI
• Choice of bi-directional, dual-ported 36-GB 15000-rpm, 73-GB 10000-rpm, or 146-GB 10000-rpm 2-Gb FC-AL disk drives	• Matches storage to the value of data — high-speed drives for high-performance or high-capacity drives for massive expansion — pay for exactly what is needed when it is needed
• Adaptive cache in the arrays used in the Sun StorEdge 6320 system	• Limits the amount of cache configuration needed to be performed by the user, thus greatly simplifying administration, improving ease of use, and enabling optimal cache behavior for current I/O patterns
• Volume masking	• Eases storage administration while allowing for a more secure environment
• Multiple back-end loops in Sun StorEdge 6020 arrays	• Helps increase performance by dedicating specific drives to specific loops, providing load balancing and allowing full use of all available bandwidth
• Five block sizes are supported: 4, 8, 16, 32, or 64 KB	• Flexible for a wide range of applications (email, OLTP, DSS, HPTC, and more)
• Multi-platform support (Solaris™ Operating Environment, IBM AIX, HP-UX, Red Hat Linux, and Microsoft Windows NT/2000)	• Adaptable and flexible support for typical multiplatform customer environments
• Built-in Storage Service Processor	• Easy and convenient upgrades through centralized point-of-service
• Sun StorEdge Remote Response (SSRR) service	• Early detection of component or system anomalies results in increased system uptime while reducing the need for staffing resources
• Open management console (CIM compliant)	• Helps reduce costs and increase manageability through virtually seamless interoperability with next-generation storage management
• Remote power cycle and reboot	• Easy energy resource management
• Multiple RAID levels	• Cost-effectively matches performance and availability to application requirements
• Redundancy throughout system (data path) with no single point of failure	• Helps reduce probability of disruption to I/O helps reduce costly downtime
• Pre-assembled, pre-tested and pre-qualified system	• Quick and smooth implementation • Customers can roll the system out of the box and install quickly, resulting in fast deployment
• Cabinet is pre-wired to accept additional trays as well as an expansion cabinet; all rails provided for maximum storage capacity	• Simplifies procedure when increasing capacity and/or performance

Features	Benefits
• Installation through the optional Sun StorEdge Array System Installation Service offering	• Experienced systems engineers help ensure proper installation

Product Family Placement

The Sun StorEdge 6320 system is the successor to the Sun StorEdge 3900 system series. As Sun's next generation midrange storage system, the Sun StorEdge 6320 system simplifies storage provisioning, improves resource utilization and ultimately reduces business costs by delivering quick, flexible and secure mapping to enterprise application requirements. This new midrange system introduces:

Intuitive, CIM compliant management software

Storage Policies for simple provisioning to specific application workloads

Immense Performance and Scalability improvements

Imbedded Storage Service Processor and Remote Monitoring

Built-in Firewall to control access to the system management consules

System Access Panel to ease system access and simplify system expansion

SAN-wide management with Sun StorEdge Enterprise Storage Manager

Solaris-based Data Services with Sun StorEdge Availability Suite

With these enhancements, the Sun StorEdge 6320 system is well positioned to serve a wide variety of mission-critical application requirements. Positioned between the Sun StorEdge 3000 family and the Sun StorEdge 9000 family, this new midrange modular system delivers an exceptional value to enterprises with multiple application deployments.

Entry-level storage applications and simple storage configurations find the answer to storage needs in the Sun StorEdge 3000 family. With immense flexibility and a simple management interface, these discrete arrays are the ideal solution for small to midium-sized businesses with a singular, non-mission critical application deployment.

For businesses that require extreme levels of performance, availability, and heterogeneity (including mainframe attach), the Sun StorEdge 9900 family is the answer.

The Sun StorEdge 6000 family delivers exceptional value by combining the flexibility of a discrete array (as in the StorEdge 3000 family). And the manageability of a monolithic system, (as in the StorEdge 9000 family). In effect, businesses get the best of both worlds: open, modular flexibility with comprehensive, robust manageability. This modular architecture allows you to get the system that's tailored for your application environment today, and then easily expand as your capacity and performance needs grow.

Key Messages

- The Sun StorEdge 6320 system providing industry leading performance and scalability
- The Sun StorEdge 6320 system is immensely flexible, enabling busineses to matches the cost of storage to the value of application data.
- The Sun StorEdge 6320 system is a complete, integrated system with modular scalability. As system capacity is expanded, performance is increased in a predictable, consistent, linear fashion.
- The Sun StorEdge 6320 system provides simple, convenient storage administration.
- The Sun StorEdge 6320 system provides a common storage infrastructure for use in multiplatform open system computing environments.

Selling Highlights

Market Value Proposition

The Sun StorEdge™ 6320 system provides businesses with a complete storage system that includes the following advantages:

- Intuitive, comprehensive management of the entire SAN intrastructure
- Provides for very high levels of data availability with full redundancy, proactive fault detection and repair, automatic call-home capability, and remote diagnostics
- Enables maximum storage resource utilization by reducing unnecessary and expensive overhead
- Reduces overall operating costs by providing highly flexible and configurable incremental scalability to meet the dynamic demands of today's challenging business applications

Target Applications

The highly flexible architecture of the Sun StorEdge 6320 system provides a mix of optimal performance and availability for business-critical applications: database, technical computing, and messaging.

Databases: Online Transaction Processing (OLTP) and Decision Support Services (DSS)

Databases for online transaction processing (OLTP) are performance-hungry business applications characterized by very high amounts of small random, non-sequential read and write transactions within concentrated periods. These transactions make the applications very sensitive to latency delays which impose a time penalty on each transaction and result in slow user response times. To alleviate these delays, ample amounts of RAID controller cache provide fast write operations. In addition, I/O can be spread across multiple spindles (or disk drives) to optimize parallel I/O for both reads and writes. Generally speaking, 36-GB 15000-rpm drives are used for OLTP-type databases.

Databases for decision support services (DSS) are performance-hungry business applications characterized by very high amounts of large sequential I/O. This makes them very cache- and bandwidth-dependent. The Sun StorEdge 6320 system provides up to 22 GB of mirrored cache and 1.6 GB/sec. of bandwidth. Generally speaking, 73-GB or 146-GB 10000-rpm drives are used for DSS-type databases.

For both OLTP and DSS databases, RAID 5 is used for read-heavy environments, and RAID 1 (1+0) is used for write-heavy environments.

The Sun StorEdge 6320 system, storage modules provide high application performance through dual 2 Gb/sec., full-fabric Fibre Channel ports and 2 GB of mirrored cache per controller in an high availability (HA) configuration. The Sun StorEdge 6320 system architecture expands the cache capabilities of a single Sun StorEdge 6020 array to an industry-leading 22 GB of raw cache. Combined with more than 45TB of capacity, the Sun StorEdge 6230 system is an unsurpassed midrange storage solution for these high-performance applications.

High-Performance Technical Computing (HPTC)

High-performance technical computing (HPTC) environments require massive data movement, have large datasets, and require high availability and management. Compute-intensive HPTC requires the storage to provide extremely fast, high-volume data movement under heavy workloads, as well as the

ability to share data at high speeds with very low latency among multiple computers. HPTC workloads are similar to DSS workloads excepting that HPTC applications are tied to very large records or files.

The modular-architected Sun StorEdge 6320 system combines distributed bandwidth with high availability and easy manageability for excellent, non-disruptive throughout performance.

Messaging: Electronic Mail

Email applications combine the workload characteristic of OLTP and DSS databases. I/O is highly random and therefore unpredictable, and record sizes range from small text-only messages to large messages with file attachments. These environments require a storage system capable of performing both transaction-heavy and throughput-heavy I/O.

The Sun StorEdge 6320 system can be scaled to optimize I/O request operations, data movement, or a combination of both. The scaling does not sacrifice data protection, making this system an ideal storage solution for messaging applications.

Mission-Critical Environments

As more and more data becomes mission critical and an increasing number of businesses need data access 24 hours/day, data availability is now more important than ever.

In order to meet the high availability (HA) characteristics required in mission-critical environments, the Sun StorEdge 6320 system storage trays come in a dual controller/dual enclosure design. Hot-swap, redundant RAID controllers, disk drives, cache, interconnect cards, data paths, mid-planes, power supplies, and cooling fans work in tandem to provide high levels of stability and data protection. In addition, the storage trays RAID controller is equipped with enough embedded battery power to completely de-stage cache to disk in case of power failure for maximum data integrity.

The Sun StorEdge 6320 system's "no single point of failure" architecture (through embedded dual fabrics), combined with Sun StorEdge Traffic Manager software on the host, also offers ease of deployment while maintaining a high level of data protection.

In addition, the Sun StorEdge 6320 system is even more suitable for mission-critical environments with its ease of management and multiplatform connectivity features.

Supported Features and Product Attributes

Feature	Description
Sun StorEdge 6320 (one cabinet only)	• Maximum of 320 volumes • 2 to 10 disk trays • Minimum of 2-GB and maximum of 10-GB mirrored battery-backed cache (1 to 5 GB usable) • Minimum capacity of 504 GB (two trays, each with seven 36-GB drives) • Maximum capacity of 20 TB (ten trays, each with fourteen 146-GB drives) • Footprint of 6.14 sq. ft. • Storage Policies (pre-configured) • Configuration Service for the Sun StorEdge 6000 family • Storage Automated Diagnostic Environment software for health and diagnostics • Sun StorEdge Availability Suite 3.1software • Sun StorEdge Enterprise Storage Manager 1.2 software • Remote support a standard feature through Sun StorEdge Remote Response (SSRR)[2] service • Can use 36-GB/15000-rpm, 73-GB/10000-rpm, or 146-GB/10000-rpm FC-AL drives • Each tray pre-configured for RAID 5 with standby hot-spare • Optional 8 and 16-port front-end (FE) switches • Integrated management, diagnostics, SSRR, and software maintenance support • All components prepackaged in familiar Sun StorEdge cabinet • Installation through Sun StorEdge Array System Installation Service
Sun StorEdge 6320 (two cabinets = base cabinet + expansion cabinet)	Includes all of the features listed above with the following differences: • Maximum of 704 volumes • 4 to 22 disk trays • Minimum of 4-GB and maximum of 22-GB mirrored battery-backed cache (2 to 11 GB usable) • Minimum capacity of 1 TB (four trays, each with seven 36-GB drives) • Maximum capacity of 45 TB (22 trays, each with fourteen 146-GB drives) • Footprint of 12.29 sq. ft (two cabinets)

[2]Necessary hardware and software to use SSRR comes standard with the Sun StorEdge 6320 system. To use this feature, the system must be under warranty or covered by a SunSpectrum Gold℠ or SunSpectrum Platinum℠ contract.

Enabling Technology

Feature Overview

The Sun StorEdge™ 6320 system employs the following technologies:

- Storage Module
- Storage Service Processor
- Switches
- Ethernet hub
- Sun StorEdge cabinet
- Software components
- Sun StorEdge Remote Response service

Storage Module

The Storage Module, as configured in the Sun Stordge 6320 system, comes only in dual controller configurations to provide high availability, controller failover, and mirrored cache, and is designed specifically for deployment in the midrange storage systems. This unique configuration is called the Sun StorEdge 6020 array.

The basic architecture of the array integrates disks, loop management, data cache, hardware RAID controller, power, cooling, an uninterrupted power supply (UPS), diagnostic capabilities, and administration into a versatile, standalone component. A tray with a hardware RAID controller is referred to as a *controller tray*. A tray without a hardware RAID controller is referred to as an *expansion tray*.

Two controller trays are referred to as a High Availability (HA) configuration because of hot-swap redundant controllers and redundant data and management paths. These features allow for cache mirroring, controller failover, and path failover capability.

One controller unit is always designated as the *master controller unit* and the other is designated as the *alternate master controller unit*. Both controllers are active Fibre Channel interfaces, but only the master controller is active for management purposes.

An array with two controller trays and no expansion trays (2x2) is the minimum array that can be used in the Sun StorEdge 6320 system. Other usable configurations are 2x4—two controller trays and two expansion trays—and 2x6—two controller trays and four expansion trays. In addition, more expansion trays can be added to a 2x2 configuration to create either 2x4 or 2x6 configurations or a 2x4 to create a 2x6 configuration.

Each tray of the Sun StorEdge 6020 array is 3RU and 18-inches deep and holds up to fourteen 1-inch drives. To enable low-cost entry points, the trays support drive depopulation where a minimum of seven drives can occupy the tray. Furthermore, depopulated trays allow the addition of drives in single increments.

The Sun StorEdge 6020 array uses a flexible, non-blocking Fibre Channel architecture, which allows the disk interconnect loops to be segmented on a tray-by-tray basis into smaller dedicated sub-loops which can all operate independently and concurrently without interference.

Each Sun StorEdge 6020 array has 2 GB of distributed cache, 1 GB of cache for every 7 to 42 disk drives.

The firmware of the Sun StorEdge 6020 array provides the following:

- Each Sun StorEdge 6020 array delivers up to 64 volumes with full volume-masking security
- The controllers of the Sun StorEdge 6020 array support five block sizes: 4 KB, 8 KB, 16 KB, 32 KB, or 64 KB.
- Enhanced RAID 5 performance employs a revolutionary hardware-based pipelined XOR (pXOR) engine which calculates the parity data at the full internal data bus speed of the array. This helps reduce the requirement for cache memory accesses which serve as a bottleneck in most RAID 5 arrays. pXOR unit can help improve performance by reducing mechanical disk seek and latency periods. The pXOR engine does this by accumulating partial XOR sums (up to 128), allowing the array to accumulate stored write-behind data in its cache memory and deliver it to the disk back-store in large chunks that can take advantage of the command sorting feature of the disks. Reducing mechanical wait states is among the best ways to improve application performance.
- Error checking and correction (ECC) cache protection is present on each 1-GB cache controller, where ECC circuitry exists on all critical data paths. All of the data paths within the pXOR engine are ECC-protected, including the data cache and the accumulator memories. ECC protection provides the transparent and automatic detection and correction of internal errors to the Sun StorEdge 6020 array.

Storage Service Processor

The Storage Service Processor of the Sun StorEdge 6320 system provides the following "out-of-band" functions:

- Monitoring of individual components within the Sun StorEdge 6320 system
- Fault isolation, verification, and notification of a FRU that is failing
- Nondisruptive download[3], both locally and remotely, of the following:
  - New Storage Service Processor software
  - Sun StorEdge 6020 array controller and loop card firmware
  - Sun StorEdge Remote Response (SSRR)-related software
- NTP server which provides synchronized time for the complete storage system

Although the Storage Service Processor manages the individual components of the Sun StorEdge 6320 system, it cannot access any of the data that resides on it because it does not have any data path connectivity. Having no access to the data path means that the Storage Service Processor has no effect on the performance of the storage components of the Sun StorEdge 6320 system and that operation of the Storage Service Processor is not mission-critical to the customer's data applications.

The following software is installed on every Storage Service Processor at the time of manufacture:

- Management software to manage components within the Sun StorEdge 6320 system[4]
- Software to perform monitoring, fault isolation, and diagnostic activities
- Software to track the appropriate software/firmware versions of the components within the Sun StorEdge 6320 system
- Software for remote support—Sun StorEdge Remote Response or SSRR service

[3]Some updrage operations may impair short term I/O performance or availability.

[4]Does not include management of any switches that either physically reside within the system or connect the system to a SAN or hosts/servers.

See "Software Components" later in this section for further details on these software packages.

Every Storage Service Processor is configured with the same hardware and software components to help ensure ease of replacement.

Each Storage Service Processor of a Sun StorEdge 6320 system is considered a peer to other Storage Service Processors of other Sun StorEdge 6320 systems. There are situations, however, where several Sun StorEdge 6320 systems are physically located within the same data center or site. In these situations, it is desirable to manage all of the systems from a single point, especially if the Sun StorEdge Remote Response feature of the system is being used[5]. Managing multiple Sun StorEdge 6320 systems that reside in the same geographical area is possible because the Storage Service Processor can consolidate multiple telemetry streams into a single external connection.

Additional connectivity to the Storage Service Processor may be required to attach one or many management consoles, service-related laptops or workstations, or a combination of these.

The Storage Service Processor offers both local and remote control/telemetry streams. A telemetry stream consists of events and alerts and provides remote support and monitoring. The Storage Service Processor provides a centralized common interface capable of executing remote and local monitoring and diagnostic commands for the Sun StorEdge 6020 arrays, Storage Service Processor, and applicable FRUs within the system.

Switches

Sun Fibre Channel 16-port switches (2-Gb Sun StorEdge network FC switch-16) can be factory-installed inside the base cabinet of the Sun StorEdge 6320 system. Both 8-port and 16-port switches (2-Gb Sun StorEdge network FC switch-8/16 and the Brocade Silkworm 3200 and 3800 fabric switches) can be field-installed inside the base cabinet also. These switches are referred to as "front-end" switches. More details regarding allowable switches that can be factory- and field-installed into the Sun StorEdge 6320 system can be found in "Configuration Rules and Requirements."

Ethernet Hub

The Ethernet hub acts as the backbone for the internal service network of the Sun StorEdge 6320 system. Specifically, the Ethernet hub acts as an aggregator for all the internal out-of-band connections, providing a single access port for the Storage Service Processor. Like the Storage Service Processor, it is not located in the datapath.

Sun StorEdge Expansion Cabinet

The Sun StorEdge 6320 system is factory-installed in a standard Sun StorEdge 72-inch cabinet, which is the same enclosure used for several other Sun StorEdge products. This provides customers a consistent look-and-feel. The customer-accessible areas of each storage system are clearly labeled as such.

[5]This helps eliminate the need for multiple phone lines to support the site.

Software Components[6]

Configuration Service for the Sun StorEdge 6000 Family
System Management Software

At a minimum, the management software of the Sun StorEdge 6320 system allows users to perform the following functions:

- Provide standard configuration menus that guide the customer to match volume characteristics to application needs—express configurations or application profiles
- Use Storage Policies to quickly and simply provision storage resources for specific application workloads
- Create, configure and clone storage pools
- Create logical storage volumes from storage pools
- Enable volume masking support
- Volume carving/slicing — two storage pools per tray can be created and then up to 64 volumes can be carved per Sun StorEdge 6020 array
- Inform monitoring and diagnostics software when configuration changes are in progress
- Add Sun StorEdge 6020 arrays into an existing Sun StorEdge 6320 system
- Check and display information about the Sun StorEdge 6020 arrays within the system
- Determine system details such as location and point-of-contact
- Obtain Sun StorEdge 6320 system ID (on a LAN sharing a SSRR modem)
- View configuration utility logs
- Partial/full shutdown of the system
- Maintain passwords of array user accounts
- Configure network settings[7]: DHCP/fixed addresses, gateway IP address, and IP port filters
- Set time/zone for the Storage Service Processor

The management software has three role-based access levels: complete access to all features, access to device-specific management features, and read access only.

The management software allows for both a partial and a full shutdown of the system. A partial shutdown causes the Sun StorEdge 6020 arrays to power down. A full shutdown causes the Sun StorEdge 6020 arrays to power down and then the Storage Service Processor to shut down gracefully.[8]

Storage Automoted Diagnostic Environment (StorADE)
Monitoring, Fault Isolation, and Diagnostics Software

This software presents a single entity to the outside world for the Sun StorEdge 6320 system (versus a group of components that reside within the system).

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[6]Software packaged with the Sun StorEdge 6320 system is not included for use on hosts, unless otherwise noted.

[7]This refers to configuration of the firewall that is located in the Service Processor Accessory (SPA) tray. See "System Architecture" section for further details as well as sections throughout this document that address Sun StorEdge Remote Response (SSRR) service.

[8]If a full shutdown occurs there is then power must be turned on at the cabinet.

Monitoring and diagnostics apply to all of the components of the system with the exception of the modem and front-end switches (if used).

More specifically, this software provides the following functionality:

- Collects health, configuration, and other non-customer-related data
- Evaluates statistical error reports
- Reports statistical data to Sun Solution Centers (when SSRR is being used)
- Notifies designated parties about events, when action is required—messages indicate system location, component location, component identifiers, probable cause[9], and recommended action
- Checks the configuration of the entire system as well as individual configuration of the Sun StorEdge 6020 arrays within the system
- Monitors message files for errors in order to obtain status information about the Sun StorEdge 6320 system
- Makes decisions on actionable service issues
- Shows the user a detailed display of the Sun StorEdge 6320 system configuration
- Supplies troubleshooting/fault isolation details for components of the Sun StorEdge 6320 system
- Provides mechanisms for service personnel to remotely access the system to gather additional data, perform maintenance, perform upgrades, and invoke diagnostics if needed
- Guides service personnel through FRU isolation, replacement, and validation
- Checks device revision for hardware, software, and firmware of the Sun StorEdge 6320 system
- Determines if power sequencer is "on" or "off"[10]

This software also performs some predictive failure analysis (PFA) such as:

- Collects FC statistics such as ITW and CRC error counts
- Uses proprietary algorithms to determine when to notify the customer/Sun Enterprise Services (if Sun StorEdge Remote Response service is being used) of an impending failure event

This software can be configured to monitor on a 24-hour basis. It provides a full simple network management protocol (SNMP) view of Sun StorEdge 6320 system components. SNMP traps are sent for actionable alerts and management applications can perform SNMP GET operations to query the system information.

All events are pre-classified into alert levels, which are notice, error, warning, and down. In addition,all event types contain an "actionable" flag, which is used to filter notification so that only actionable events are sent. Actionable means that work is required by service personnel

Software To Track SW/FW Versions of Sun StorEdge 6320 System Components

This software tracks the appropriate software/firmware versions of the components within the Sun StorEdge 6320 system, determines which patches may be required, and provides logic needed to install the appropriate patches to the system.

[9]Normally faults are isolated to a single FRU with the exception of passive component failures—for example, GBICs, Fibre Channel link cables, and so on—where further diagnosis may be required.

[10]This software, however, cannot determine if the power is "on" or "off." It can only determine "on" or "off" status of the power sequencers.

Software for Remote Support

Software to enable the Sun StorEdge Remote Response (SSRR) service is installed on the Storage Service Processor's disk. This software is not enabled/activated for use until a contract is in place between the customer and Sun Services for remote service support. See below for more information on this software.

Thin Scripting Client/Remote Configuration CLI

The remote configuration CLI provides a scriptable CLI which communicates with the Sun StorEdge 6320 system using an out-of-band secured interface. It avoids the need for the customer to telnet to the Sun StorEdge 6320 system—the remote configuration CLI uses https to communicate with the Sun StorEdge 6320 system's Storage Service Processor. The utility provides a remote interface for the configuration CLI functions that reside on the 6320 Storage Service Processor without requiring access to the Storage Service Processor itself.

This utility is optional. The customer must install a CLI package on one of their hosts that has network access to the Sun StorEdge 6320 system. CLI commands can then be run from this host.

The Thin Scripting Client is available on the Solaris Operating Environment, Microsoft Windows NT, and Windows 2000.[11] It is Java™ technology-based, resides on the customer's host, and accesses the Sun StorEdge 6320 system's Storage Service Processor. Since the client is Java technology-based, it can easily be adapted to run on other operating systems that have the appropriate Java Virtual Machine (JVM) version installed. Scripts can be created in any scripting language.

The utility creates an authenticated session with the Storage Service Processor (SSP). By default, all messages are encrypted. The user can specify an option for non-encrypted communications. The first command must be a login with a valid userid and password. This login command starts a JVM on the client host and establishes a session to the SSP. Each subsequent command is sent to the SSP and the response returned to the user. When the user logs out (or the session times out), the JVM and session terminate.

The Thin Scripting Client/Remote Configuration CLI for the Solaris Operating Environment ships on a CD with the Sun StorEdge 6320 system.

Sun StorEdge Availability Suite Software

Sun StorEdge Availability Suite software does not reside on the Storage Service Processor of the Sun StorEdge 6320 system. This software includes both Point-in-Time (PIT) Copy and Remote Mirror software.

Sun StorEdge Availability Suite "Point-in-Time" Copy (previously called Sun StorEdge Instant Image software, or II) is a point-in-time snapshot facility that runs on the Solaris Operating Environment. A PIT copy is an instantly available, time-fixed, replicated view of a momentarily quiesced volume. Once a PIT copy is taken, there is immediate read/write access to both the original and copy volumes. In addition, this software tracks the differences between the two volumes, caused by writes, from the time of the copy. This capability allows the data on either of the two volumes to move forward in time independently of the other, which means that applications can access the two volumes and modify the data on them independently.

Because Sun StorEdge Instant Image software tracks differences between the volumes, the volumes can be quickly PIT-copied subsequent to the first PIT copy. A resynchronization of this type can occur either from the copy to the original or from the original to the copy. Immediately after the PIT copy is established, or re-established, the volumes can be remounted and the applications using them can resume

[11]There are plans for the Thin Scripting Client to be available on HP-UX, IBM AIX, Red Hat Linux, and Sun Linux.

processing. The PIT copy is established, or re-established, either when the CLI prompt returns or the next shell script command is read.

Sun StorEdge Availability Suite software's "Remote Mirror" (previously called Sun StorEdge Network Data Replicator software, or SNDR) is a remote replication facility for the Solaris Operating Environment that allows customers to replicate disk volumes between physically separate primary and secondary sites in real time. To transport data, Remote Mirror uses any Sun network adapter that supports TCP/IP. It is designed to be active during normal application access to the data volumes and continually replicates the data to the remote site. Customers can update the data on the secondary volume by issuing a command to synchronize the primary and secondary volumes. Customers can also restore data from the secondary volume to the primary volume by issuing a command to reverse resynchronize the volumes.

The Remote Mirror software uses volume sets that the customer defines. A volume set consists of a primary volume residing on a local site and a secondary volume residing on a remote site. The volume set also includes a bitmap volume on each site to track write operations and differences between the volumes.

Customers can use RAID volumes as part of a Sun Remote Mirror software strategy. Volumes can be any RAID level. The RAID levels of volumes in a volume set do not have to match.

Sun StorEdge Enterprise Storage Manager (ESM) Software

Sun StorEdge Enterprise Storage Manager (ESM) software does not reside on the Storage Service Processor of the Sun StorEdge 6320 system. This is host-based software and is most effectively deployed from a Solaris Operating Environment-based Sun management station.

Sun StorEdge ESM software enables the following:

- Centralized management of multiple Sun StorEdge 6320 systems, Sun StorEdge 6120 arrays, Sun StorEdge T3 arrays, Sun StorEdge 69X0 systems, Sun StorEdge 39X0 systems, and their associated SANs/hosts—for building an enterprise view of the customer's storage environment
- Provides storage managers a central location from which to view frequently accessed information needed for day-to-day SAN management
- Provides valuable information such as health—path and device level—status, storage asset inventory, and current device configuration status
- The flexibility to "drill-down" into other Sun Open SAN device configuration and health management tools

Sun StorEdge Remote Response (SSRR) Service

The Sun StorEdge Remote Response service allows Sun trained personnel to remotely monitor, troubleshoot, diagnose and service the Sun StorEdge 6320 system 24 hours a day, 7 days-a-week.

This service offers the customer fast turnaround when the monitoring and diagnostic software resident on the Storage Service Processor detects a serviceable action and subsequently dials up a Sun Solution Center. This software transmits the service alert along with any pertinent data for analysis. The support center then dials back into the Sun StorEdge 6320 system to gather further details or resolve the problem, often without involving the customer or affecting data availability.

Monitoring and Diagnostics Software

The main security features of this software are:

- 128-bit secure socket layer (SSL) encryption support for the user interface between the customer's management LAN and the Storage Service Processor
- Password protection in the user interface

Management Software

- Role-based access level support allows multiple user roles. Admin, storage, and guest users are pre-defined and, if needed, additional users can be created.

Volume Masking

Volume masking is the term used for assigning volume permissions—read-only, read/write, or none—to a host. Volume masking eases storage administration while allowing for a more secure environment. When a volume is masked from a host, that volume is not available to be configured from that host and thus cannot be assigned to multiple hosts accidentally.

Each host HBA port is assigned a unique world-wide number (WWN). Volume masking verifies each host I/O with an ID by checking the host port WWN against the permissions. The Sun StorEdge™ 6020 array controller firmware does not recognize (register) a WWN until the WWN is recorded by the management software.

WWNs can either be assigned to a specific volume or a specific set of volumes, or multiple WWNs can be grouped and assigned to a specific volume or a specific set of volumes.

Sun StorEdge Remote Response Service

Security for the customer's LAN is provided at four levels:

- Secure shell (ssh) is used between the Storage Service Processor and the modem, as well as between the Sun SSRR server and the Storage Service Processor.
- The NTC requires authentication before allowing traffic from the modem to SP-LAN.
- A firewall/router impedes hackers trying to come in through the public switched telephone network (PSTN) through the modem to the Storage Service Processor.
- The Storage Service Processor requires a login and password and uses a challenge/response scheme, when SSRR is configured, for access before anyone can access it.

Customers can also add a firewall between their LAN and their Sun StorEdge 6320 system to provide an additional layer of security.

Storage Service Processor

Lower level functions of the Sun StorEdge 6320 system's Storage Service Processor are protected through a password that prohibits unauthorized access and thus provides an added measure of security. This password is available to the customer's Sun Services provider.

Command Line Interface (CLI)

This CLI uses encryption and authentication.

System Architecture

This section provides an overview of the main architectural features of the Sun StorEdge™ 6320 system. Architectural depictions of the Sun StorEdge 6320 system with one (base) and two (base + expansion) cabinets are provided in Figures 3 and 4.

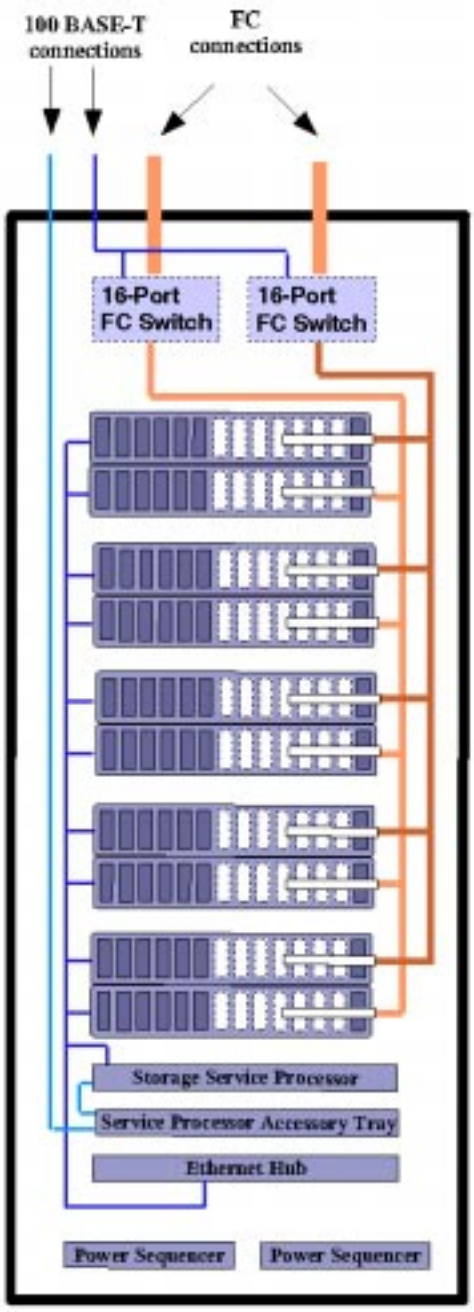


Figure 3. Sun StorEdge 6320 system — base cabinet configuration

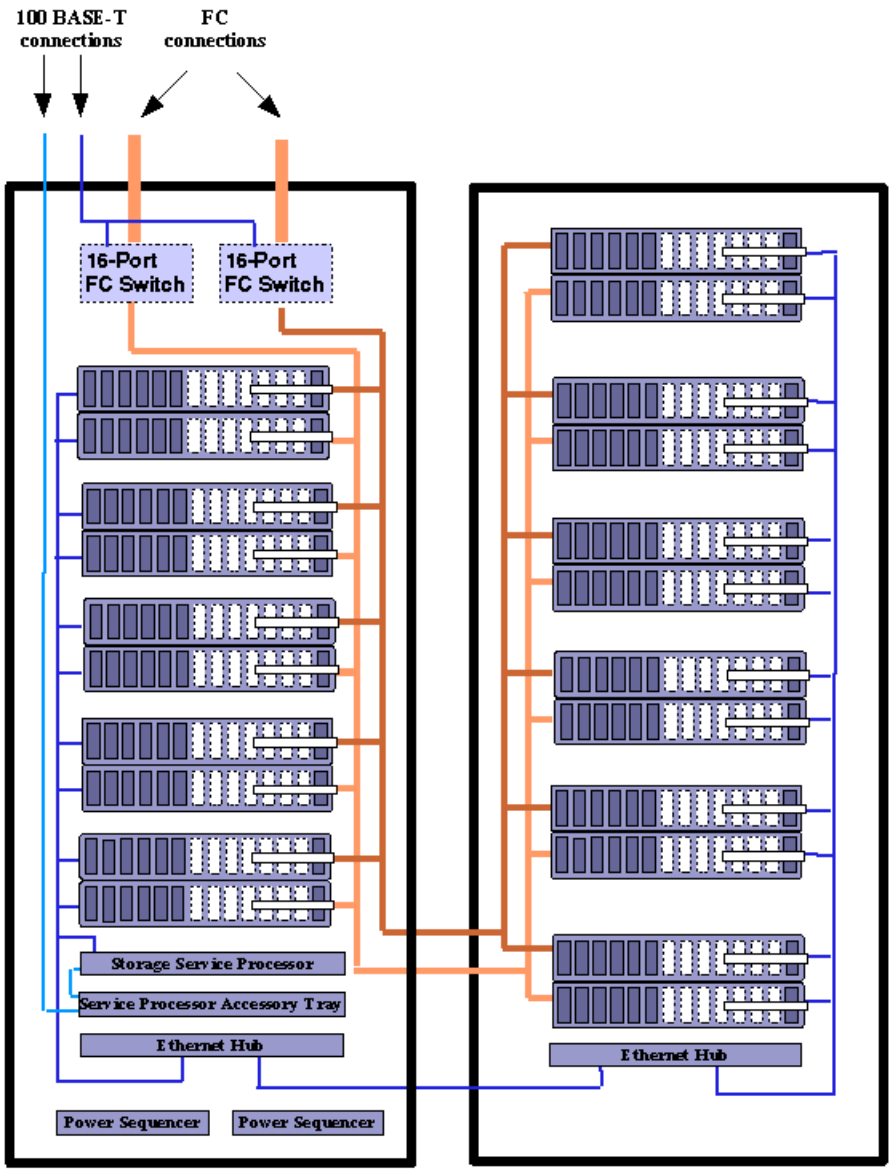


Figure 4. Sun StorEdge 6320 system — base and expansion cabinet configuration

Power Sequencers

The power sequencers provide redundant power sources for the Sun StorEdge 6020 arrays that reside in the Sun StorEdge 6320 system. Only one power connection is provided to the Ethernet hub, Storage Service Processor, and Service Processor Accessory tray of the Sun StorEdge 6320 system.

Ethernet Hub

The Ethernet hub provides Ethernet connectivity for all of the internal components of the Sun StorEdge 6320 system. One hub is rackmounted in each of the base and expansion cabinets of the Sun StorEdge 6320 system.

Storage Service Processor

Customer configuration data from the Storage Service Processor is duplicated on the Storage Service Processor's internal hard disk and an external USB flash disk. The flash disk is not part of the Storage Service Processor, but rather an external device that is attached to Storage Service Processor through a USB cable. In the event that a Storage Service Processor fails and has to be replaced, the flash disk from the failed Storage Service Processor can be removed and placed on the replacement Storage Service Processor. A software tool provided in the Storage Service Processor can retrieve the personality from the flash disk (in less than a second) to restore all the Storage Service Processor configuration settings.

The Storage Service Processor has a single power source input. If the power distribution unit (PDU) supplying power to the Storage Service Processor fails, there is no notification of the power failure nor any subsequent storage system component notifications that would inevitably follow. This condition exposes the Sun StorEdge 6320 system to potential data unavailability if any of the failed-over components should fail before the monitoring agent heartbeat period elapses.[12]

Service Processor Accessory (SPA) Tray

The Sun StorEdge 6320 system comes with the necessary hardware and software to take advantage of the remote support feature of this system (SSRR). This hardware consists of a network terminal concentrator (NTC), modem, firewall/router, and integrated power supply module, all of which physically reside in the Service Processor Accessory (SPA) Tray in the base cabinet of the Sun StorEdge 6320 system. Additionally, there is a USB relay for power sequencer control. The USB Relay module physically resides outside of the SPA tray.

The NTC provides a modem connection point for SSRR. Sun Solution Center engineers connect through the modem to the NTC to log onto the Storage Service Processor. A PPP connection is then established between the Storage Service Processor and remote support server using the NTC to pass the datastream only.

The modem allows the Sun StorEdge 6320 system to communicate with Sun Solution Centers over a dial-up telephone connection. This modem provides the conversion of the RS-232 serial data stream from the Storage Service Processor to the customer's local phone service. The modem is instructed to dial-up the local support center whenever the Storage Automated Diagnostic Environment (StorADE) detects the need for a service action or to periodically check-in with a heartbeat message. Sun service personnel dial-back into the Storage Service Processor to obtain additional data about the alert or, in some cases, fix it remotely. For a group of Sun StorEdge 6320 systems, a modem can be shared by designating one system's modem to act as the modem proxy for the other system's modem.

The firewall/router provides an additional layer of security for Sun by using network address translation (NAT) and allows for disabling specific network services from the Customers LAN.

Service Panel

Access to the Storage Service Processor is through a service panel. The service panel is bolted to the back of the Sun StorEdge 6320 system base cabinet inside the back cover.

Serial connections on the service panel can be used as field hook-ups to proprietary device debug ports—for example, Sun StorEdge 6020 array serial port—or as a modem/Internet port in locations where the internal modem is not appropriate.

[12]Statistical analysis by NWS Serviceability RAS engineers indicates that the likelihood of such a failure resulting in data unavailability is .0029/1000 units given the average MTBF of the service processor is 29 KHrs and the heartbeat occurs every 8 hours.

The service panel also allows interconnection of a larger network of Storage Service Processors or system hosts, that is, aggregating multiple Storage Service Processors into a LAN.

Wiring Harness

A wiring harness is provided for physically connecting the internal components of this system. The wiring harness is pre-configured for the maximum upgradeable configuration of the purchased storage system including most of the wiring required for the expansion cabinet. The wiring harness allows any cable to be individually replaced (serviced) in the event of failure.

Fibre Channel Switches

Figures 3 and 4 depict the Sun StorEdge 6320 system with front-end switches located in the base cabinet of the Sun StorEdge 6320 system. However, customers do not need to use front-end switches inside this system.

If the customer opts to use two "front-end" switches, these switches can be factory- or field-installed inside the base cabinet or located externally to the base cabinet. Switches cannot be rackmounted in the expansion cabinet.

Switches are not connected through Ethernet to the service network for management and service from the Storage Service Processor, even if they physically reside inside the base cabinet. Management of these switches must be provided by host-based software on hosts attached directly or indirectly (through a SAN) to the Sun StorEdge 6320 system or through Sun StorEdge Enterprise Storage Manager software.

Front-end switches are used for both data interconnections and external host/SAN connections. The number of ports available for external host/SAN connections is dependent on two factors:

- Number of Sun StorEdge 6020 storage array controllers in the base and (if used) expansion cabinets
- Number of ports on the front-end switches

Further details regarding available ports as a function of these two variables can be found in the section entitled "Configuration Rules and Requirements."

Sun StorEdge 6020 Arrays

Sun StorEdge 6020 Array — Front View

The front of the Sun StorEdge 6020 array (Figure 5) provides user access to the fourteen Fibre Channel RAID disk drives. Each disk drive has its own dual Fibre Channel interface and circuitry and front-panel LEDs for drive activity: ready (green), fault (amber), and OK to remove (blue). Disk drives are positioned sideways with their SIS LEDs at the bottom.

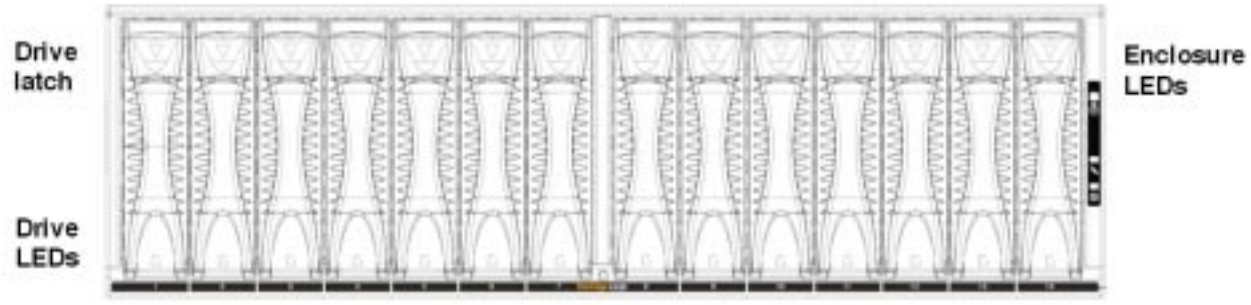


Figure 5. Front view of the Sun StorEdge 6020 array

Sun StorEdge 6020 Array — Rear View

The rear of the Sun StorEdge 6020 array controller unit (Figure 6) provides user access to redundant Fibre Channel unit interconnect cards (lower left and right), one RAID controller card (lower center), and redundant power/cooling units (upper left and right):

- Each of the two unit interconnect cards (UICs) includes interface circuitry and two Fibre Channel connectors for interconnecting units.
- The RAID controller card includes RAID controller hardware and firmware, one 2-Gb host Fibre Channel interface, a 10BASE-T/100BASE-T Ethernet host interface, and an RJ-45 COM service port.
- Each of the two power/cooling unit contains a power supply, two cooling fans, an integrated UPS battery, and status indicators: ready (green), fault (amber), and OK to remove (blue).

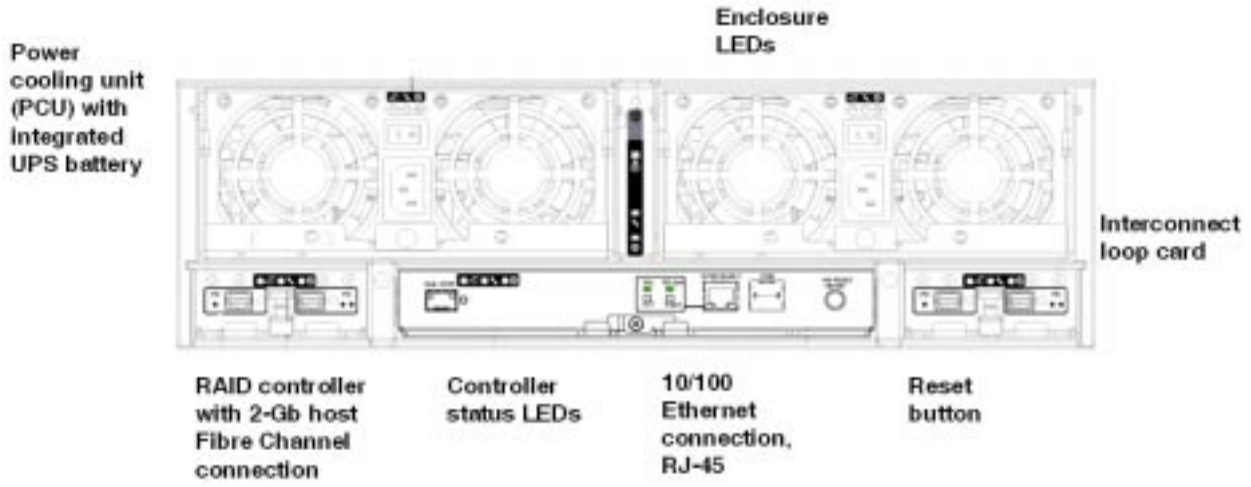


Figure 6. Rear view of the Sun StorEdge 6020 array

Sun StorEdge 6020 Array — Interconnect

The Sun StorEdge 6020 array uses two unit interconnect cables for connecting units together (Figure 7). The unit interconnect cables use a proprietary connector. In addition to FC-AL signals, these cables also carry a serial bus which functions as the nerve system of the Sun StorEdge 6020 array. The serial bus

carries FRU state information to the RAID controller card that then processes the information which is used to create syslog entries.

The unit interconnect cables can be replaced without taking the array off-line. One cable MUST be in place at all times for the array group to remain functional.

This cable is then attached to either the optional front end switches or to the rack patch panel.

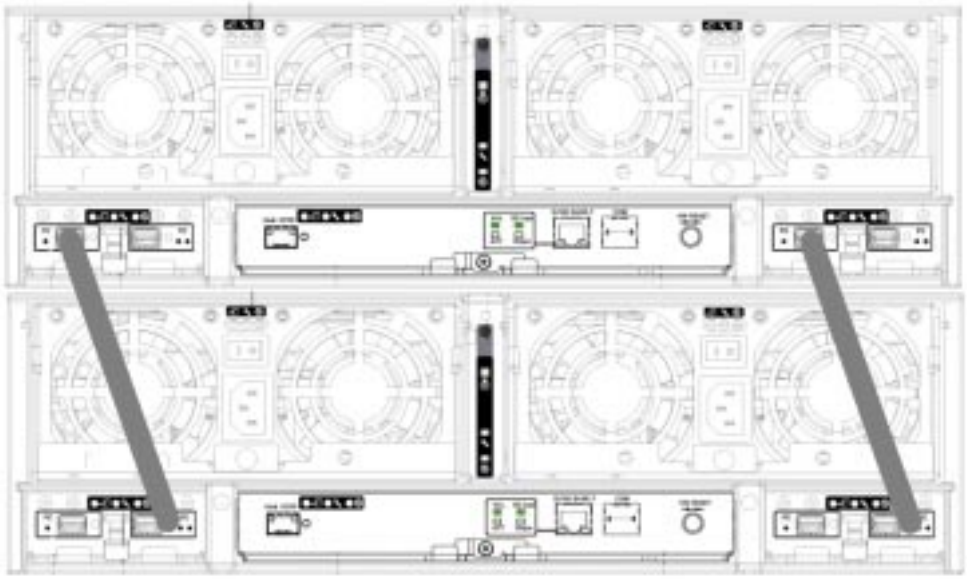


Figure 7. Sun StorEdge 6020 array, interconnect

Sun StorEdge 6020 Array — Basic Building Blocks

For the Sun StorEdge 6020 array, there are two basic modular building blocks: dual controller trays (2x2) and dual expansion trays (0x2). The dual controller trays (2x2) provide additional loop-back cables to provide failover with no single point of failure.

Using the basic modular building blocks, the Sun StorEdge 6020 array has a total of three possible array group configurations: 2x2, 2x4, and 2x6. See the following section for further details.

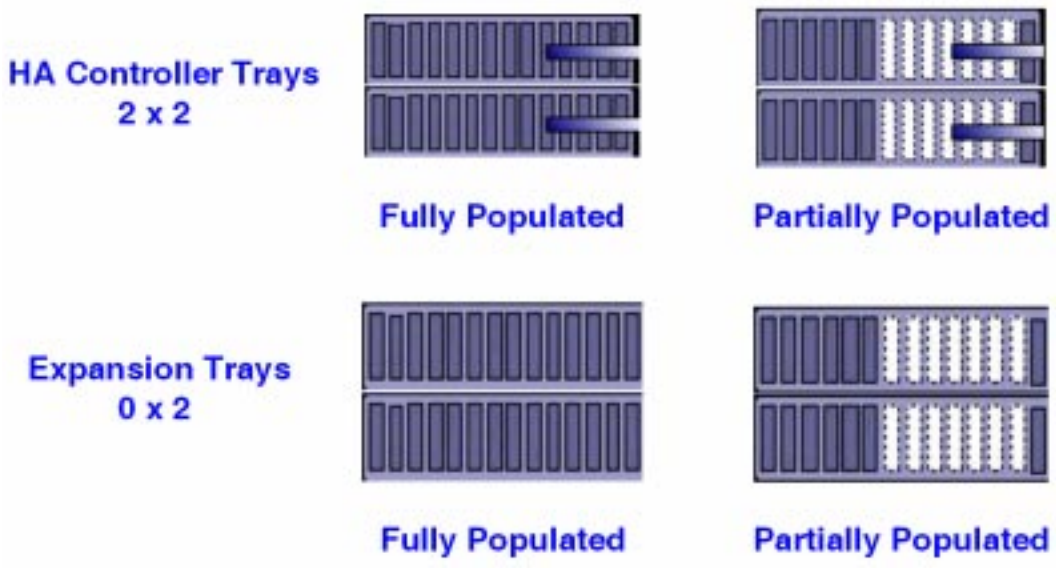
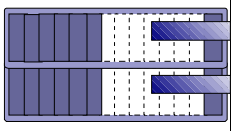
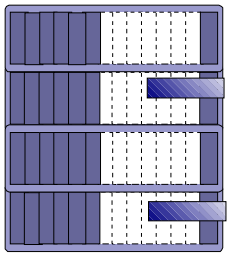


Figure 8. Building blocks for the Sun StorEdge 6020 array

Sun StorEdge 6020 Array — Naming Convention

C x T = C (*# controller trays*) x T (t*otal # disk trays*)

C X T	Total # of RAID Controller	Total # of Disk Tray	Controller Tray	Expansion Tray	Spindle Counts/ Capacity	Controller Placement
2x2	Two	Two	Two	—	14 – 28 drives 504 GB – 4 TB	
2x4	Two	Four	Two	Two	28 – 56 drives 1 TB – 8 TB	

C X T	Total # of RAID Controller	Total # of Disk Tray	Controller Tray	Expansion Tray	Spindle Counts/ Capacity	Controller Placement
2x6	Two	Six	Two	Four	42 – 84 drives 1.5 TB – 12 TB	

Sun StorEdge 6020 Array — Trays and Drives

A maximum of 10 Sun StorEdge 6020 array trays can reside in the base cabinet of the Sun StorEdge 6320 system (see Figure 3). A maximum of 12 Sun StorEdge 6020 array trays can reside in a Sun StorEdge 6320 expansion cabinet (see Figure 4). Thus, a maximum of 22 Sun StorEdge 6020 array trays can reside in the Sun StorEdge 6320 system if it uses both a base and an expansion cabinet.

The base and expansion cabinets can be populated with any combination of 2x2, 2x4, and 2x6 Sun StorEdge 6020 array configurations. (Figures 3 and 4 depict the cabinets fully populated with 2x2s.)

Every tray of the Sun StorEdge 6020 array can be populated with a minimum of seven and a maximum of fourteen bi-directional dual-ported 2 Gb-capable FC-AL disk drives. Each disk drive FRU is concealed by a removable front bezel installed in a SPUD-3, 1-inch drive bracket which holds the disk drive and provides electromagnetic interference (EMI) shielding. The drive plus the SPUD-3 drive bracket constitutes the disk FRU.

The 14th drive bay of each tray can optionally be used for a non-floating hot-spare. Hot-spares cannot be shared amongst trays.

Each tray's chassis is designed with drive slot bypass capability and analog signal detection to distinguish between a disk drive and a diskless SPUD-3 drive bracket.

An expansion tray can be upgraded to a controller tray by inserting a hardware RAID controller card.

Sun StorEdge 6020 Array — Unit Interconnect Card (UIC)

Each tray includes two unit interconnect cards (UICs) with SIS-compliant LEDs. The UIC has three major interrelated functions:

- Joins drives and trays in a daisy chain
- Performs management functions to monitor the back-end loop and drives
- Provides environmental monitoring for the enclosure housing the disk drives and PCUs.

There are two UICs per array, one for each back-end loop.

Sun StorEdge 6020 Array — RAID Controller Card

The RAID controller card provides cache, RAID management, administration, diagnostics, and external interfaces. Controller trays include one controller FRU. Two controller trays are united in the Sun StorEdge 6320 systems for cache mirroring and controller redundancy.

The controller is both the data processing and administrative "brain" of the Sun StorEdge 6020 array. The controller provides all the Sun StorEdge 6020 array's external interfaces and controls all back-end activities either related to data management or administration.

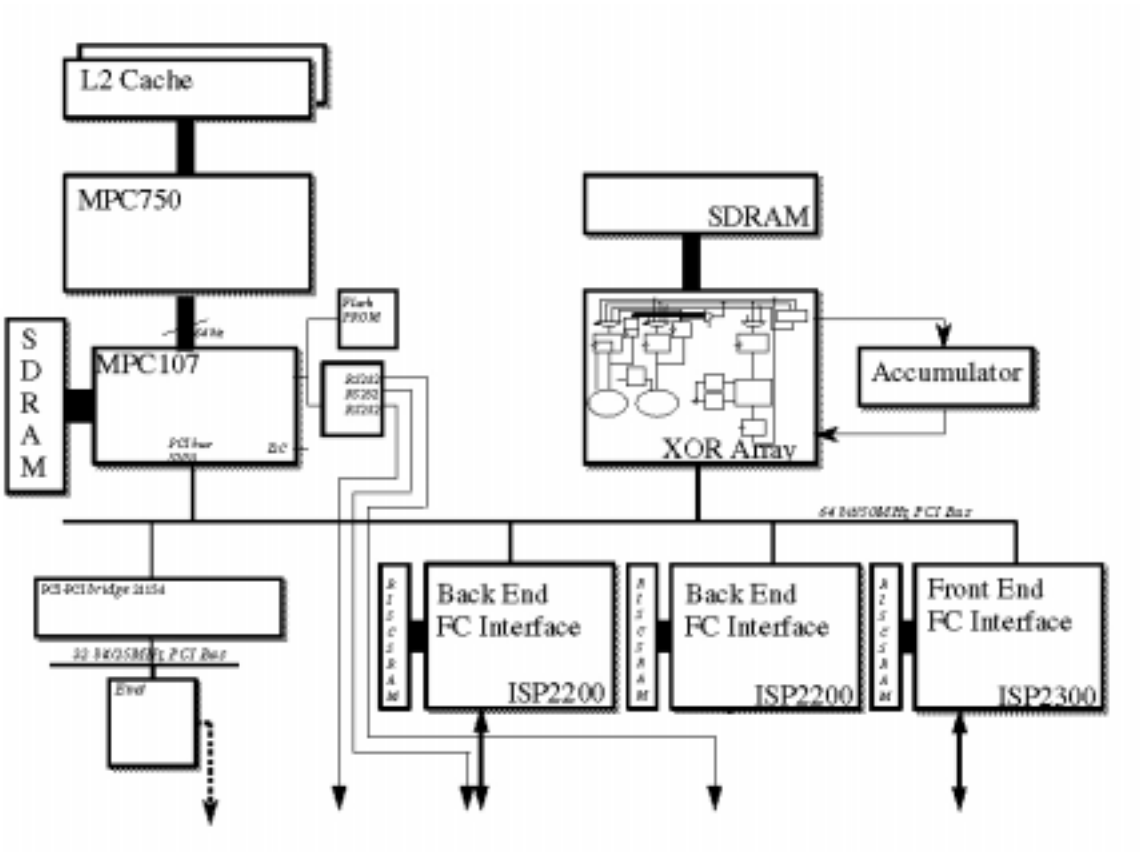


Figure 9. Sun StorEdge 6020 array hardware RAID controller architecture

Although united in an HA configuration, each controller unit of a Sun StorEdge 6020 array used in a Sun StorEdge 6320 system processes data to its disks independently. However, write data that is placed in cache to be destaged at a later time is mirrored to the second controller unit cache prior to returning an ACK (acknowledgment) through the host interface. The mirroring is accomplished over one of the two back-end FC-AL loops. Under normal operation, Loop 1 in each controller unit remains independent of the alternate controller's Loop 1. Loop 2, providing the cache mirroring path, is a continuous loop between the two HA controllers. To help ensure an open path for cache mirroring performance, fewer drives are put on Loop 2.

In normal operation, each path to a given controller carries only data for the volumes contained within the same Sun StorEdge 6020 array — the path serves as the active or primary path for those volumes. However, each controller/path is also capable of carrying data intended for the other controller/path — the path also serves as the secondary or passive path if necessary.

Sun StorEdge 6020 Array — Power Cooling Units

Each tray includes two redundant power and cooling units (PCUs) with SIS-compliant LEDs and temperature sensors. Each PCU has an external power connection, allowing for connection to two independent power grids or circuits. There is one internal 410-watt auto-switching power supply per PCU. In case of an external power failure or a PCU failure, one power supply is sufficient to indefinitely power a maximum of fourteen drives contained within a tray.

Sun StorEdge 6020 Array — External Interfaces

The hardware RAID controller of the Sun StorEdge 6020 array has three external interfaces. A 2-Gb Fibre Channel (LC) port transports data to the application host through the system patch panel . An Ethernet port handles administrative—monitoring, diagnostic, and configuration—communication with the Storage Service Processor of the Sun StorEdge 6320 system. And, finally, an RJ-45 serial port (RS-232) is used for advanced service procedures such as boot diagnostics.

Only application data travels through the FC port. Only administrative information travels through the Ethernet port (network channel)[13]. This separation of responsibilities has the following advantages:

- A path for communicating with the Sun StorEdge 6020 array remains available even if the data path or application host has failed.
- Administrative traffic does not interfere with data traffic which results in greater performance.
- Application data is shielded from those individuals performing everyday service and administration which results in greater security of application data.

[13]A small amount of administrative information can flow through the FC port but is only used in certain configurations for device discovery.

Reliability, Availability, and Serviceability (RAS)

Reliability

The Sun StorEdge™ 6320 system has the following reliability features:

- Monitoring and diagnostic software aids early detection/notification of faults on a 24-hour basis[14]
- Automated and online firmware upgrade/downgrade through a combination of monitoring and diagnostic software that tracks version levels of Sun StorEdge 6320 system components
- Error checking and correction on disk drives
- Skip sectors and spare cylinders on disk drives
- Automatic sector reallocation on RAID controllers
- Link redundancy chip and 8- to 10-bit encoding on FC-AL loops of the Sun StorEdge 6020 array
- ECC on data cache
- Passive midplane (except ID signature) in the Sun StorEdge 6020 array
- Hardware support for parity for RISC RAM in the Sun StorEdge 6020 array
- PCU of the Sun StorEdge 6020 array proactively adjusts fan speed based on temperature monitoring
- Temperature sensors in the Sun StorEdge 6020 array are located closer to heat spots to provide accurate temperature measurements
- High-performance modular loop card serial communication protocol of the Sun StorEdge 6020 array offers failure fencing and fault containment in case of hardware failure

Availability

The Sun StorEdge 6320 system offers 99.99 percent system availability through the following availability features:

- Dual power supplies for front-end switches (if used)
- Redundant power distribution units (PDUs) capable of serving sufficient switched 110/120V outlets
- Redundant power sequencers
- No negative impact on data availability due to Storage Service Processor or internal component LAN failure
- No negative impact on data availability when non hot-swap FRUs are replaced because of redundant architecture
- Hot-swap components in the Sun StorEdge 6020 array, including disk drives, power supplies, cooling fans, integrated UPS batteries, interconnect cards, loops, loop switching cards, administration channels, and controllers
- Dual hot-swappable redundant load-sharing/load-balancing auto-sensing 110VAC/220VAC power supplies (with individual power cord) in the Sun StorEdge 6020 array
- Integrated hot-swappable redundant UPS batteries in the Sun StorEdge 6020 array for cache backup

[14]If SSRR is used.

- Four redundant electrically independent cooling fans (with temperature sensors) in the Sun StorEdge 6020 array
- Hot-swappable redundant unit interconnect cards (UIC) in the Sun StorEdge 6020 array
- Hot-swappable redundant dual-ported FC-AL drives and dual backend drive loops per controller in the Sun StorEdge 6020 array
- Hot-swappable redundant RAID controllers for automatic failover and cache mirroring in the Sun StorEdge 6020 array
- Redundant data interfaces on the Sun StorEdge 6020 array
- Temperature sensors in the Sun StorEdge 6020 array for continuous threshold-based temperature monitoring.
- Persistent group reservation for use with any software supporting industry-standard SCSI-3 persistent reserve commands such as clustering software
- Automatic hardware-based bypass of a faulty drive in case of a faulty drive causing loop disruptions

Serviceability

The Sun StorEdge 6320 system has the following serviceability features:

- Phonehome capability (SSRR-ready)
- Enclosure chassis LED (Locator/Fault LED)
- Low FRU count (nine[15])
- Sun-standard FRU ID support
- Wiring harness has the ability for cables to be individually replaced in the event of a failure
- Service access panel provides connection to the Storage Service Processor in order to perform routine maintenance or reconfigure the storage system
- Every Storage Service Processor is configured with the same hardware and software components to facilitate ease of replacement
- The four basic FRUs of the Sun StorEdge 6020 array — drives, PCUs (with integrated UPS battery), interconnect cards and RAID controllers — can be hot-swapped
- SIS compliant status/failure LED on each FRU of the Sun StorEdge 6020 array to quickly locate the defective component
- Addition of blue LEDs on the front of the Sun StorEdge 6020 array to ensure only failed FRUs get pulled for replacement
- Summary fault LEDs on the front the Sun StorEdge 6020 array for a visual indicator that a FRU needs service
- Upgradeable drive firmware (with only the associated volume off-line during the upgrade)
- Detection and reporting for incorrect drive position in the Sun StorEdge 6020 array
- Automatic drive-ID selection on the Sun StorEdge 6020 array
- Quick snap locking mechanisms on the Sun StorEdge 6020 array for easy insertion/extraction of disks and other FRUs

[15]FRUs include the Storage Service Processor, Service Processor Accessory (SPA) tray, Ethernet hub, disk drives, power/cooling unit (PCU), loop card, midplane, battery, and hardware RAID controller. The last six are FRUs of the Sun StorEdge 6020 array.

- Blind-mate connectors on the Sun StorEdge 6020 array to avoid bent pins on FRU insertion
- Fibre Channel ECHO ELS support allows for both external echo test (invoked from Sun StorEdge 6020 array) and passive echo test (invoked from switch)
- External and internal loopback test of Sun StorEdge 6020 array's RAID controller (front-end and back-end FC ports and QLogic ASICs)
- Hardware in the Sun StorEdge 6020 array supports the creation of diagnostics loops of disks for performing background tests
- Loop card standalone self tests (SAT) part of the Sun StorEdge 6020 array's firmware

Sun StorEdge™ 6320 System — Fully Loaded, One Cabinet

Feature	Specification
Physical Planning	
Dimensions	75.0 inches high (190.5 cm) 23.9 inches wide (60.7 cm) 37.0 inches deep (94 cm)
Footprint	6.14 sq. ft. (0.5706 sq. m)
Weight (full complement of Sun StorEdge™ 6020 arrays)	1,700 pounds (771 kilograms)
FRU Access at Front	Disk drives, Storage Service Processor, midplane/chassis enclosure
FRU Access at Rear	Controller card, loop cards, power/cooling units, Fibre Channel switches (if used), Storage Service Processor accessory tray, Ethernet hub[16]
Required Clearances (for service)	Front = 48 inches (122 cm) Rear = 36 inches (92 cm)
Power Cord Length	15 feet (4.6 m)
Environmental (operating)	
Temperature	5º to 35º C (41º to 95º F)
Relative Humidity	10% to 90% noncondensing, maximum gradient 10% per hour
Altitude	9,840 feet (3,000 meters)
Shock	3.0 g for maximum duration of 11 ms (half sinewave)
Vibration (from any axis X, Y, Z)	- 0.15 g on z-axis; 0.10 g on x- and y-axes; 5 to 500 Hz sinusoidal
Heat Output	~ 15,000 BTU
Environmental (nonoperating)	
Temperature	-40º to 60º C (-40º to -76º F), noncondensing
Relative Humidity	93% noncondensing, maximum gradient 10% per hour
Altitude	39,370 feet (12,000 meters)
Shock	1.0 inch roll-off freefall, front to back rolling directions
Vibration (from any axis X, Y, Z)	0.5 g on Z-axis; 0.25 g on X- and Y-axes; 5 to 500 Hz sinusoidal
Connectors	
Service Panel	RJ45 and industry-standard USB connectors; LC and MPO optical connectors
FC Switch (if factory installed)	Shortwave GBICs
Power Requirements	
Power Rating	4,200 Watt (maximum) Two dedicated 200 to 220 VAC, 30A circuit breakers
Plug Types (US)	NEMA L6-30P for 200 to 240 VAC
Plug Types (international)	32A, single phase IEC 309, connected for 220 to 240 VAC

[16]Access to switches, tray, and hub also requires the removal of trim panel covering and two screws on the front of the unit in order to replace these FRUs.

Feature	Specification
AC Power	200 to 240 VAC @ 47 to 63 Hz single phase
Standards Compliance	
Safety and Emissions	IEC 60950, EN 60950, UL 60950, FCC Part 15 (47CRF15B), CISPR 22, EN 61000-3-2, EN 61000-3-3
Immunity	CISPR 24; EN 61000-4-2, 61000-4-3, 61000-4-4, 61000-4-5, 61000-4-6, 61000-4-8, and 61000-4-11
Interfaces and Protocols	FC-AL, SCSI, HTTP, HTML, Telnet, and FTP

Sun StorEdge 6320 System — Fully Loaded, Two Cabinets

The specifications of a Sun StorEdge 6320 system that uses two fully loaded cabinets are the same as the specifications of a Sun StorEdge 6320 system that uses only one fully loaded cabinet, with the following differences.

Feature	Specification
Physical Planning	
Dimensions	75.0 inches high (190.5 cm) 47.8 inches wide (121.4 cm) 37.0 inches deep (94.0 cm)
Footprint	12.29 sq. ft. (1.411 sq. m)
Weight (full complement of Sun StorEdge 6020 arrays)	3,600 pounds (1633 kilograms)
Heat Output	~ 28,000 BTU
Power Rating	8,400 Watt (maximum) Four dedicated 200 to 220 VAC, 30A circuit breakers

SSRR Enabled

The Sun StorEdge™ 6320 system provides a comprehensive suite of management interfaces that allows complete control and configuration of the storage array, even if Sun StorEdge Remote Response (SSRR) is used/enabled. Both the secure web-based and remote command line interfaces allow the administrator to provision storage through an intuitive interface. In other words, even when SSRR is enabled/used, customers still can manage and configure their StorEdge 6320 system to provide the storage service they require.

Disk Drives

Individual disk drives in the Sun StorEdge™ 6020 array are not visible to the application host; rather, they are configured into one or two RAID 5, RAID 1(1+0), or RAID 0 storage pools per tray.

Each drive has a private region of 200 MB reserved for system use. All remaining capacity is available for use by the application host. On the master and alternate master controller units, the system area is used on all drives as a mirror, containing a copy of the operating system, file system, and firmware. Multiple versions of firmware can be saved, allowing the flexibility to back out or revert to an earlier version if necessary. On the master controller unit, the system area also includes configuration information, system log, and other assorted files for internal use.

Sun StorEdge 6020 Array — Administration Path

The administration path within the Sun StorEdge 6020 array provides connectivity from the controllers to all FRUs within the Sun StorEdge 6020 array. It also connects the controllers to the external Ethernet and serial ports of the array. It is over this path that configuration, diagnostics, and monitoring takes place.

The Sun StorEdge 6020 array has two internal serial lines connecting the CPU with all non-disk FRUs. These lines are used as redundant internal administration paths, which communicate configuration, control, monitoring, and diagnostic information. The serial lines extend through the daisy-chain unit interconnect cables to all controllers in the array, creating a single administrative domain.

The external Ethernet administration path is used to exchange monitoring, diagnostic, and configuration information between the Sun StorEdge 6020 array unit's CPU and the Storage Service Processor of the Sun StorEdge 6320 system. The CPU has no access to the application data and no application data is available through the administration path.

All administration and external communication, on behalf of both controller units in the Sun StorEdge 6020 array, are conducted through the master controller. Only if the master controller fails does the alternate master controller take over administration.

Path Failures

Path failure occurs when I/O is interrupted for any reason other than a controller failure; the failure could be in a cable, in a host adapter, or could even occur because of a non-I/O root cause such as removal of an application host system I/O board. Regardless of the cause of the interruption, I/O requests targeted at a volume eventually times out. The I/Os are then redirected to the alternate path for that volume. The redirection is managed on the application host by the alternate pathing software appropriate to that host.

On SPARC-based Solaris™ Operating Environment platforms, the user can choose between software developed by Sun (available on a host installation CD that ships with the Sun StorEdge 6320 system) or VERITAS Dynamic Multipathing (DMP). On other platforms, users can choose between Sun StorEdge Traffic Manager (SSTM) 3.0 or VERITAS DMP software if available for that platform . Further details on multipathing can be found in "Configuration Rules and Requirements."

Controller Failures

To the application host, a controller failure appears identical to a path failure, and the response and recovery procedures are also identical. I/O requests down the channel of the failed controller time out. The host-based alternate pathing software reroutes I/O down the failover channel. The software periodically pings the primary channel, and when it gets a response, it then re-routes I/O back to the primary channel. The time it takes to affect a controller failover is slightly longer than the time needed to affect a volume failover.

Data Flow

The application data path is used exclusively to process I/O between the application host and disks. No configuration or monitoring is performed over the data path, other than normal SCSI inquiry requests. No configuration or monitoring is handled over the internal data paths, other than to store/retrieve configuration and monitoring data to/from the reserved system area on the disk drives.

Data Cache

The primary purpose of data cache in the arrays used in the Sun StorEdge 6320 system is to provide a low latency buffer for write data, allowing writes to be quickly acknowledged to the application host. The cache is especially crucial to RAID 5 write performance, because it can coalesce several partial-stripe writes into a single read/modify/write operation. A secondary benefit of the cache is to buffer read data, allowing for low latency on repeated reads of the same data.

Adaptive cache is a key feature of the Sun StorEdge 6020 array. The algorithms used for allocating, coalescing, and flushing data are automatically and dynamically adjusted based on I/O patterns. This limits the amount of cache configuration needed to be performed by the user, thus greatly simplifying administration, improving ease of use, and enabling optimal cache behavior for current I/O patterns.

Each Sun StorEdge 6020 array controller includes 1-GB SDRAM data cache. Cache organization and behavior are tightly coupled with LUN stripe width and Sun array block size (the amount of data in the stripe that goes on each disk). The Sun StorEdge 6020 array block size is a system configuration parameter set by the user to be 4 KB, 8 KB, 16 KB, 32 KB, or 64 KB. The cache buffer size equals the block size, so the block size configuration parameter defines both the size of the cache buffers and the unit of data written to each disk in a RAID stripe.

Volume Masking

When a volume is masked from a host, it is not available to be configured from that host and thus prevents the volume from being assigned to multiple hosts accidentally.

Each host HBA port is assigned a unique world-wide number (WWN). Volume masking verifies each host I/O with an ID by checking the host port WWN against the permissions. The Sun StorEdge 6020 array controller firmware does not recognize (register) a WWN until the WWN is recorded through the management software.

WWNs can either be assigned to a specific volume or a specific set of volumes, or they can be grouped and assigned to a specific volume or a specific set of volumes.

Software/Firmware Upgrades/Downgrades

The Sun StorEdge 6320 system's software/firmware components are installed in the factory by Sun. Updates are available through servers (maintained by Sun Microsystems) and CD-ROMs.[17] Field replacement of hardware and field installation of new hardware can require upgrades to software/firmware located on the Sun StorEdge 6320 system.

The Sun StorEdge 6320 system has a small set of upgradeable components, which include the following:

- Sun StorEdge 6020 array controller and loop card image
- Sun StorEdge 6020 array disk image
- Monitoring and diagnostics software image
- Storage Service Processor image
- Router/firewall image

Collections of patches for the images mentioned above are put together to form the next update to the Sun StorEdge 6320 system. This helps reduce the administrative burden on the customer because they do not have to assess how different software/firmware versions interact with each other. The software that is installed on the Storage Service Processor is a fully tested collection that is installed as a set in order to reduce complexity.

Monitoring and diagnostic software and software that tracks version levels of Sun StorEdge 6320 system components work together to help ensure that appropriate firmware is installed and necessary configuration information is restored after addition of a new Sun StorEdge 6320 system component or FRU replacement. The monitoring and diagnostic software discovers the new hardware and invokes the software that tracks version levels of individual components within the Sun StorEdge 6320 system. This software then upgrades/downgrades the component firmware as necessary (after confirmation from the user) and then runs an install script to restore the configuration information.

The Sun StorEdge 6320 system supports online firmware upgrades of the components mentioned above, except the Sun StorEdge 6020 array disk image. Online firmware upgrade means that the upgrade is performed in an orderly manner and there is full data availability during the firmware upgrade operation. When upgrading the disk image firmware, the applicable Sun StorEdge 6020 array must be taken offline during the upgrade process, during which time no I/O exchanges can occur and no access to data is possible.

Remote Lights-Out Power Management

Power sequencers and a USB relay control the power sequencing. This allows the user to remotely shut down most of the components within the Sun StorEdge 6320 system. Only the Storage Service Processor and and a few other components are kept running to allow for a subsequent remote power-on operation. However, a full shutdown— including the service processor—can be initiated, and power will need to be turned on at the physical system location manually.

[17]CD-ROMs are only available from Sun Services. They do not ship with the Sun StorEdge 6320 system.

Depopulated Trays

The Sun StorEdge 6320 system supports depopulated trays. In other words, each tray can have a minimum of seven drives. Further details about this feature can be found in "Enabling Technology," "Configuration Rules and Requirements" and "Best Practices."

Expansion Unit Support

The Sun StorEdge 6320 system supports adding "controllerless" trays to existing Sun StorEdge 6020 arrays being used in either the base or expansion cabinets. These controllerless trays are also referred to as "expansion units." Further details about this feature can be found in "Enabling Technology," "Configuration Rules and Requirements" and "Best Practices."

Mixed Drive Sizes Within Trays

Different drive sizes can be used within each tray of the Sun StorEdge 6320 system. The same drive size should be used within a storage pool (each tray can have a maximum of two storage pools). If different drive sizes are used within a storage pool, the lowest drive size dictates the usable capacity of each drive in the storage pool. For example, if a seven-drive storage pool has six 73-GB drives and one 36-GB drive, only 36 GB of capacity on each of the seven drives is recognized.

In addition, the drive size of the hot-spare (if a hot-spare is used) must be greater than or equal to the smallest drive sizes in the storage pools in the tray.

Volume Masking

The Sun StorEdge 6320 system provides volume masking, whereby a customer can select a collection of volumes and expose them to a collection of HBAs. The Sun StorEdge 6320 system does not know in which hosts these HBAs are installed. Thus, the customer must type in HBA port WWNs that are allowed to access a group of volumes.

The management software also allows for creation of volume groups and initiator groups. This greatly simplifies volume masking for host cluster configurations, where the same volumes are exported to a set of host HBAs with the same or different permissions for different HBA groups.

Fabric Support

The Sun StorEdge 6320 system supports only FC-PH Class 3 Service. It does not support Class 2 fabric.

Localization and Internationalization

The Sun StorEdge 6320 system is compliant with localization and internationalization policies. The following components are localized:

- The management software GUI is localized into French, Japanese, and Simplified Chinese.
- Messages are localized into Japanese only.
- Installation instructions are localized into French and Japanese.
- Documentation is localized into French, Japanese, Simplified Japanese, Traditional Chinese, and Korean.

Default Configuration

Factory-Installed Front-End Switches

Front-end switches that are installed in the factory arrive at the customer's doorstep configured with G_ports. Otherwise, these switches are not configured—for example, zoning—in the factory.

Factory-Installed Trays and Drives

Each disk tray associated with the same HA controller configuration ships from the factory with the same quantity of drives.

All drives in a tray shipped from the factory have the same capacity and spindle speed. Storage pools within a tray can have mixed capacity hard disk drives, though. See "Best Practices" for further details.

Disk drives in controller trays can have different capacity/spindle speeds than disk drives in expansion trays.

All trays for the Sun StorEdge™ 6320 system are shipped pre-configured from the factory with one RAID 5 storage pool and a hot-spare in the 14th bay of the tray, regardless of the number of drives that were ordered in the tray.

Maximum Number of Direct-Attach Host Connections When Using Front-End Switches

The Sun StorEdge 6320 system's base cabinet provides for ten direct-attach host connections when front-end switches are used within the base cabinet. This allows customers to connect five hosts in a highly available configuration. Additional cabling must be ordered and installed within the the Sun StorEdge 6320 system's base cabinet to increase the number of external host connections (more than five hosts in a highly available configuration) in this particular situation.

Remote Power

From the factory, the remote power feature is not enabled. The Sun StorEdge 6320 Series 1.0 Storage System Installation Guide indicates how to enable and use remote power.

Encryption

Both encrypted and unencrypted services are provided on the Sun StorEdge 6320 system—that is, the monitoring and diagnostic software as well as the management software support both encrypted[18] and unencrypted[19] communications. These software components are configured in the factory to use a form of encryption that can be used anywhere in the world. Customers can choose to use either of these services (encrypted or unencrypted) and must program the firewalls of their Sun StorEdge 6320 system appropriately. For instance, the customer can limit the Sun StorEdge 6320 system's net interfaces—for example, access to the monitoring and diagnostic software using SSL is as simple as specifying port 7443, while the unsecured version is accessed by specifying port 7654.

[18] https

[19] http

Configuration Rules and Requirements

Initial System Configuration

The initial configuration of the Sun StorEdge™ 6320 system is performed through a serial interface. There is a special configuration user that guides customers through establishing the identity of their Sun StorEdge 6320 systems.

Depopulated Trays

For proper air circulation and cooling of the arrays used within the Sun StorEdge 6320 system, a diskless SPUD-3 drive bracket is mandatory (must be ordered) for every unused/empty drive slot in a tray.

Replacement — Storage Service Processor

If the Storage Service Processor is ever replaced, the network settings must first be configured. This can be performed through a serial interface to the SP. Once the network settings are made, the remainder of the installation can be performed from a web browser.

Multiple Volumes

Allowed Quantities

The Sun StorEdge 6020 array allows for volume "slicing" or multiple volumes which is similar to partitioning a hard drive of a desktop computer. This feature allows smaller storage addressing increments, which is particularly useful when an array is configured with large-capacity drives.

A maximum of 64 volumes or "slices" can be made per HA controller configuration. In other words, the maximum number of volumes for each of these arrays is 64 whether the array is a 2x2, 2x4, or 2x6. Each slice is mapped to a volume.

Volume Slicing

The following are rules for volume slicing:

- The minimum slice size is 10 MB and must be rounded on a RAID stripe boundary. For example, if a RAID stripe is 9 blocks, and 1 GB is to equal 100 blocks, then the minimum slice size is 108 blocks (12x9 because 11x9 is only 99, not enough for 100, so go one more set of nine blocks over).
- All slice sizes must be in multiples of the minimum slice size—for example, 10 MB, 20 MB, 30 MB, 40 MB, etc. Not 15 MB, 12.5 MB, 22 MB, and so on.
- The maximum slice size is 2 TB and is dependent on the storage pool size, that is, it cannot exceed the storage pool size. Also, no concatenation of volumes is allowed.
- All space in a storage pool need not be used.

Multiple Storage Pools

The maximum number of storage pools per tray is two. Thus, 2x2, 2x4, and 2x6 configurations can have a maximum of 4, 8, and 12 storage pools, respectively. These storage pools can then be presented to the host by the Sun StorEdge 6020 array controller as a logical unit number (LUN) or can be sliced into volumes which are then presented to the host by the Sun StorEdge 6020 array controller as a LUN. Storage pools must consist of whole drives and drives cannot be partitioned into different storage pools.

A storage pool is created with a single RAID level. A RAID level is either striped (RAID 0), striped with parity protection (RAID 5), or striped and mirrored (RAID 1+0). A storage pool can be created with only one RAID level and multiple pools can not be comined into larger pools.

Hot-Spare Drives

If a hot-spare drive is required, it must be declared when the first volume on a tray is created.

If drive 14 is used as a hot-spare for a particular storage pool, it must be specified when this pool is created. If the user creates two storage pools, both pools can use the 14th drive as a hot-spare. If the user wants to designate a hot-spare to an existing storage pool, that volume must be deleted and then recreated with a designated hot-spare (drive 14).

The hot-spare must always reside in slot or bay 14 of a tray.

Sun StorEdge Remote Response (SSRR) Service

Customers who reside in any of the following countries can enable/activate SSRR 'as is' out of the box.: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, India, Ireland, Italy, Japan, South Korea, Malaysia, Mexico, The Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Romania, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, U.K., and U.S.A.

Customers in other countries need to contact Sun or a licensed Sun Reseller/Service Provider to enable/activate SSRR.

Within the Sun StorEdge 6320 system's base cabinet, there is an internal network, sometimes referred to as the "Component Network." It is totally contained in the base cabinet and connects the Sun StorEdge 6020 arrays and the Storage Service Processor through an Ethernet hub. This network is used for administration of the system's internal components (excluding front-end switches) and data telemetry going to the Storage Service Processor. For security and supportability reasons, when SSRR has been activated, customers do not have direct access to this network. (Because the Sun StorEdge 6320 system is physically located at the customer's site, it is impossible to prevent someone from physically accessing this hub.) If access is made by the customer or a representative of the customer, the customer is in technical violation of the SSRR agreement/contract. Without SSRR, the customer can have any level of access to this network that they desire. However, it is highly recommended that this "Component Network" not be directly connected to some general LAN.

If a customer performs repair/reconfiguration activities (whether locally or remotely) that are faulty, they may get charged T&M by Sun Services for remote diagnostic/repair activities that are performed as a result of the faulty repair/reconfiguration activity.

Finally, the customer must have a suitable telephone connection to enable the service.

Front-End Switch Support

The Sun StorEdge 6320 system can be used with or without integrated front-end switches. Integrated front-end switches mean they are physically located within the base cabinet of the system, whether factory- or field-installed. Front-end switches can also reside outside of the system's base cabinet.

Sun offers four switches that can physically reside within the base cabinet of the Sun StorEdge 6320 system. Only one, the 2-Gb Sun StorEdge network FC switch-16, can be factory-installed. The other three can be field-installed. These are the 2-Gb Sun StorEdge network FC switch-8, Brocade Silkworm 3200 (2-Gb FC 8-port switch), and Brocade Silkworm 3800 (2-Gb FC 16-port switch).

In cases where the Sun StorEdge 6320 needs to be connected to a large number of hosts, larger switches such as the 2-Gb Sun StorEdge network FC switch-64, Brocade Silkworm 12000 or the McDATA Intrepid 6064 Director should be used. For such deployments, the 6020 storage modules are connected directly to these switches through the System Access Panel.

Connectivity

Front-End Connections

The Sun StorEdge 6230 system supports host connectivity in a variety of ways. Generally speaking, the system can be connected directly to a host's Fibre Channel HBA or can be connected indirectly through a supported SAN interconnect.

No Front End Switches

For Sun StorEdge 6320 systems that do not use front-end switches (within the base cabinet), two host connections can be made to each Sun StorEdge 6020 array in the rack. This is commonly referred to as “direct-attach”. These two connections can be used to connect one customer host in a highly available configuration. It is possible to connect one host per Sun StorEdge 6020 array or have a maximum of eleven hosts per Sun StorEdge 6320 system that is fully populated with Sun StorEdge 6020 array 2x2 configurations. With up to eleven Sun StorEdge 6020 arrays (2x2 configurations) in a fully populated Sun StorEdge 6320 system, up to twenty-two discrete host connections are provided. Since no switches are deployed in this configuration, storage capacity cannot be shared among host. To use the Sun StorEdge 6320 system as a multi-host storage pool, the rack-based Sun StorEdge 6020 arrays must be connected to a switched fabric.

Front End Switches

By using front-end Fibre Channel switches (whether internal or external to the system), it is possible to connect multiple hosts per Sun StorEdge 6020 array with no additional host configuration required.

The Sun StorEdge 6320 system's base cabinet provides for ten direct-attach host connections, when dual 16-port front-end switches are used within the base cabinet. This allows customers to connect five hosts in a highly available configuration. The amount of host that may be connected directly to the dual internal 16 ports switches directly depends on the amount of 6020 controller modules installed. Additional cabling must be ordered and installed within the the Sun StorEdge 6320 system's base cabinet to increase the number of external host connections (more than five hosts in a highly available configuration) in this particular situation.

Available Ports Using Front-End Switches

If using front-end switches inside the base cabinet (whether factory- or field-installed), the number of available ports for connection into hosts or a SAN is a function of one of the following:

- The number of Sun StorEdge 6020 array controllers in the base and, if used, expansion cabinets
- The number of ports on the front-end switches

The following table provides the number of available ports as a function of these two variables.

Number of Available Host or SAN Ports[20] (per switch)	Dual Integrated Switches	Number of HA Controllers
7	8-port	1
6	8-port	2
5	8-port	3
4	8-port	4
3	8-port	5
2	8-port	6
1	8-port	7[21]
15	16-port	1
14	16-port	2
13	16-port	3
12	16-port	4
11	16-port	5
10	16-port	6
9	16-port	7
8	16-port	8
7	16-port	9
6	16-port	10
5	16-port	11

Volume Count

Volume count is based on how many and what combination of Sun StorEdge 6020 arrays the customer uses in their system. Note that customer volume count requirements are only one aspect to configuration. Peformance, RAS, and volume size requirements also need to be taken into consideration. The following table indicates the number of attainable volumes based on numbers of HA controller configurations and whether or not an expansion cabinet is required.

[20]May require additional Fibre Channel cables and reconfiguration of the switches.

[21]Note how more than seven controller pairs cannot be used with 8-port front-end switches.

Volume Range	Expansion Cabinet Required?	Required Number of Sun StorEdge 6020 arrays
1 – 64	No	1
65 – 128	No	2
129 – 192	No	3
193 – 256	No	4
257 – 320	No	5
321 – 384	Yes	6
385 – 448	Yes	7
449 – 512	Yes	8
513 – 576	Yes	9
577 – 640	Yes	10
641 – 704	Yes	11

Multipathing

Multipathing Software — General

Host software is required for multipathing. All hosts connected to the same Sun StorEdge 6020 array must use one—and only one—form of multipathing management.

Multipathing Software — Solaris Operating Environment Hosts

Sun StorEdge Traffic Manager for SPARC-based Solaris Operating Environment hosts ships with the Sun StorEdge 6320 system as part of Sun StorEdge SAN Foundation software release 4.2. This software provides the following features:

- Multipath configuration management
- Failover support
- Automatic path fail-back—automatic fail-back to the restored path occurs when a failed path is restored subsequent to a failover
- Load balancing support—selects and routes I/O requests from attached hosts/initiators using round-robin services to the Sun StorEdge 6320 system

Multipathing Software — Non-Solaris Operating Environment Hosts

Sun StorEdge Traffic Manager (SSTM) 3.0 software is also available for hosts running IBM AIX, HP-UX, Windows NT, and Windows 2000. This is available from Sun for a fee; it does not ship with the Sun StorEdge 6320 system and must be purchased from Sun Microsystems.

SSTM (for HP-UX, Windows NT, Windows 2000) provides the following features:

- Multipath configuration management
- Failover support

- Automatic path fail-back—when a failed path is restored subsequent to a failover, SSTM causes automatic fail-back to the restored path
- Load balancing support—selects and routes I/O requests from attached hosts/initiators using round-robin services to the Sun StorEdge 6320 system

SSTM (for AIX) provides the following features:

- Multipath configuration management
- Failover support
- Automatic path fail-back—when a failed path is restored subsequent to a failover, SSTM causes automatic fail-back to the restored path

Management Software

Sun StorEdge Component Manager software should not be used on the Sun StorEdge 6320 system. Features and functionality of this software have been captured in the Sun StorEdge 6320 system's management software.

Netscape Navigator™ 4.7.x (and above) and Microsoft Internet Explorer 4.x (and above) must be used as browsers to use the GUI of this management software.

Operating Environments

Solaris Operating Environment

The Solaris™ 8 Operating Environment (04/01) or later is required for hosts connecting to the Sun StorEdge 6320 system.

Sun Linux

The Sun StorEdge 6320 system is not yet supported on Sun Linux.

Non-Solaris Operating Environment Support

The Sun StorEdge 6320 system is supported on the following non-Sun platforms:

- Microsoft Windows NT Enterprise Server 4.0 SP6 (both single- and multi-path support)
- Microsoft Windows 2000 Server and Advanced Server SP3 (both single- and multi-path support)
- IBM AIX 4.3.3 (32-bit) (both single- and multi-path support)
- IBM AIX 5.1 (32- and 64-bit) (both single- and multi-path support)
- Hewlett-Packard HP-UX 11.0 and 11.i (both single- and multi-path support)
- Red Hat Linux 7.2 (single-path support only)

Solaris™ Operating Environment Support

All of the platforms in the following table are supported on Solaris 8 and 9 Operating Environments.

Server Platform	HBA						
	Part No.	Throughput	Protocol	Single or Dual Channel	Max I/O Slots for HBA	FC Connections per HBA	Max I/O Slots per Server
Sun Blade™ 1000, 2000	X6799A	1 Gb	PCI	Single	3	1	3
	X6727A	1 Gb	PCI	Dual	3	2	6
	X6767A	2 Gb	PCI	Single	4	1	4
	X6768A	2 Gb	PCI	Dual	4	2	8
Ultra™ 60[22]	X6799A	1 Gb	PCI	Single	4	1	4
	X6727A	1 Gb	PCI	Dual	4	2	8
	X6767A	2 Gb	PCI	Single	4	1	4
	X6768A	2 Gb	PCI	Dual	4	2	8
Ultra 80[23]	X6799A	1 Gb	PCI	Single	3	1	3
	X6727A	1 Gb	PCI	Dual	3	2	6
	X6767A	2 Gb	PCI	Single	3	1	3
	X6768A	2 Gb	PCI	Dual	3	2	6
Netra 20	X6799A	1 Gb	PCI	Single	2	1	2
	X6727A	1 Gb	PCI	Dual	2	2	4
Netra 1120	X6799A	1 Gb	PCI	Single	4	1	4
	X6727A	1 Gb	PCI	Dual	4	2	8
Netra 1125	X6799A	1 Gb	PCI	Single	4	1	4
	X6727A	1 Gb	PCI	Dual	4	2	8
Netra t1400, t1405	X6799A	1 Gb	PCI	Single	3	1	3
	X6727A	1 Gb	PCI	Dual	3	2	6
Sun Fire V210	X6799A	1 Gb	PCI	Single	1	1	1
	X6768A	2 Gb	PCI	Dual	1	2	2
Sun Fire V240	X6799A	1 Gb	PCI	Single	3	1	3
	X6768A	2 Gb	PCI	Dual	3	2	6
Sun Fire V1280	X6799A	1 Gb	PCI	Single	6	1	6
	X6727A	1 Gb	PCI	Dual	6	2	12
	X6767A	2 Gb	PCI	Single	6	1	6
	X6768A	2 Gb	PCI	Dual	6	2	12
Sun Enterprise™ 220R, 250, Sun Fire 280R	X6799A	1 Gb	PCI	Single	4	1	4
	X6727A	1 Gb	PCI	Dual	4	2	8
	X6767A	2 Gb	PCI	Single	4	1	4
	X6768A	2 Gb	PCI	Dual	4	2	8

[22]Not supported with switches. Direct attach only.
[23]Not supported with switches. Direct attach only.

Server Platform	HBA						
	Part No.	Throughput	Protocol	Single or Dual Channel	Max I/O Slots for HBA	FC Connections per HBA	Max I/O Slots per Server
Sun Enterprise 420R	X6799A	1 Gb	PCI	Single	3	1	3
	X6727A	1 Gb	PCI	Dual	3	2	6
	X6767A	2 Gb	PCI	Single	3	1	3
	X6768A	2 Gb	PCI	Dual	3	2	6
Sun Enterprise 450	X6799A	1 Gb	PCI	Single	7	1	7
	X6727A	1 Gb	PCI	Dual	7	2	14
	X6767A	2 Gb	PCI	Single	7	1	7
	X6768A	2 Gb	PCI	Dual	7	2	14
Sun Enterprise 3000, 3500	X6799A	1 Gb	PCI	Single	6	1	6
	X6727A	1 Gb	PCI	Dual	3	2	6
	X6767A	2 Gb	PCI	Single	6	1	6
	X6768A	2 Gb	PCI	Dual	6	2	12
	X6757A	1 Gb	SBus	Dual	6	2	12
Sun Enterprise 4000, 4500	X6799A	1 Gb	PCI	Single	8	1	8
	X6727A	1 Gb	PCI	Dual	6	2	12
	X6767A	2 Gb	PCI	Single	8	1	8
	X6768A	2 Gb	PCI	Dual	8	2	16
	X6757A	1 Gb	SBus	Dual	12	2	24
Sun Enterprise 5000, 5500	X6799A	1 Gb	PCI	Single	8	1	8
	X6727A	1 Gb	PCI	Dual	6	2	12
	X6767A	2 Gb	PCI	Single	8	1	8
	X6768A	2 Gb	PCI	Dual	8	2	16
	X6757A	1 Gb	SBus	Dual	12	2	24
Sun Enterprise 6000, 6500	X6799A	1 Gb	PCI	Single	12	1	12
	X6727A	1 Gb	PCI	Dual	6	2	12
	X6767A	2 Gb	PCI	Single	12	1	12
	X6768A	2 Gb	PCI	Dual	12	2	24
	X6757A	1 Gb	SBus	Dual	12	2	24
Sun Fire V880, 480R	X6799A	1 Gb	PCI	Single	8	1	8
	X6727A	1 Gb	PCI	Dual	8	2	16
	X6767A	2 Gb	PCI	Single	8	1	8
	X6768A	2 Gb	PCI	Dual	8	2	16
Sun Fire 3800	X6748A	1 Gb	cPCI	Dual	8	2	16
Sun Fire 4800, 4810	X6799A	1 Gb	PCI	Single	8	1	8
	X6727A	1 Gb	PCI	Dual	15	2	30
	X6767A	2 Gb	PCI	Single	15	1	15
	X6768A	2 Gb	PCI	Dual	15	2	30
	X6748A	1 Gb	cPCI	Dual	4	2	8
Sun Fire 6800	X6799A	1 Gb	PCI	Single	8	1	8
	X6727A	1 Gb	PCI	Dual	31	2	62
	X6767A	2 Gb	PCI	Single	31	1	31
	X6768A	2 Gb	PCI	Dual	31	2	62
	X6748A	1 Gb	cPCI	Dual	4	2	8

Server Platform	HBA						
	Part No.	Throughput	Protocol	Single or Dual Channel	Max I/O Slots for HBA	FC Connections per HBA	Max I/O Slots per Server
Sun Enterprise 10000	X6799A	1 Gb	PCI	Single	30	1	30
	X6727A	1 Gb	PCI	Dual	30	2	60
	X6767A	2 Gb	PCI	Single	30	1	30
	X6768A	2 Gb	PCI	Dual	30	2	60
	X6757A	1 Gb	SBus	Dual	12 per domain	2	24 per domain
Sun Fire 12K	X6799A	1 Gb	PCI	Single	35	1	35
	X6767A	2 Gb	PCI	Single	35	1	35
	X6768A	2 Gb	PCI	Dual	35	2	70
Sun Fire 15K	X6799A	1 Gb	PCI	Single	71	1	71
	X6767A	2 Gb	PCI	Single	71	1	71
	X6768A	2 Gb	PCI	Dual	71	2	142

Non-Solaris Operating Environment Support

Operating System	Version	HBA			Multipathing Driver
		Vendor	Model	Throughput	
MS Windows NT Enterprise Server	4.0 SP6	Emulex Emulex Emulex QLogic QLogic	LP8000-N1 LP9002L LP952 QLA2310 QLA2342	1 Gb 2 Gb 2 Gb 2 Gb 2 Gb	SSTM 3.0
MS Windows 2000 Server and Advanced Server	SP3	Emulex Emulex Emulex QLogic QLogic	LP8000-N1 LP9002L LP952 QLA2310 QLA2342	1 Gb 2 Gb 2 Gb 2 Gb 2 Gb	SSTM 3.0
HP-UX	11.0 and 11.i	HP HP	A5158A 6795A	2 Gb 2 Gb	SSTM 3.0
IBM AIX	4.3.3 (32-bit)	IBM IBM	FC6227 FC6228	1 Gb 2 Gb	SSTM 3.0
IBM AIX	5.1 (32- and 64-bit)	IBM	FC6227 FC6228	1 Gb 2 Gb	SSTM 3.0
Red Hat Linux	7.2	QLogic QLogic	QLA 2200F/66 QLA 2300	1 Gb 1 Gb	Not Available

System Installation

Sun strongly recommends that customers purchase the Sun StorEdge™ Array System Installation Service or have a Sun-trained representative perform this installation.

Random vs. Sequential Environments

Use the table below as a guide for finding information about particular application types:

Topic	See Section
OLTP Database (with text and graphics)	"Random Write Environments — Record Sizes Greater Than 16 KB"
OLTP Database (with text records only)	"Random Write Environments — Record Sizes Less Than 8 KB"
DSS Database	"Sequential Environments"
HPTC Environment	"Sequential Environments"

Random Write Environments — Record Sizes Greater Than 16 KB

For heavy random I/O write environments—for example, an OLTP database with text and graphics—which use record sizes greater than 16 KB, it is desirable to maintain a 1:14 ratio between controllers and high-rpm drives; that is, you install only disk trays with controllers or 2x2 configurations of the Sun StorEdge 6020 array using 15000-rpm disks; as a result, cache is evenly distributed to handle writes. Also, because of the higher write penalty inherent when using RAID 5, a RAID 1+0 configuration is recommended.

Random Write Environments — Record Sizes Less Than 8 KB

For heavy random I/O write environments—for example, an OLTP database with just text records—which use record sizes less than 8 KB, expansion units can be added to help reduce overall system costs, but it is advisable to not exceed a 1:28 ratio between controllers and high-rpm drives; that is, you install disk trays with controllers plus one expansion tray per controller or 2x4 configurations of the Sun StorEdge 6020 array using 15000-rpm disks; as a result, cache is evenly distributed to handle writes. Again, because of the higher write penalty inherent when using RAID 5, a RAID 1+0 configuration is recommended.

Random Read Environments

For random I/O read environments, expansion units should be added to help reduce overall system costs. Thus, it is desirable to maintain a 1:42 ratio between controllers and high-rpm drives; that is, you install disk trays with controllers plus two expansion trays per controller or 2x6 configurations of the Sun StorEdge 6020 array using 15000-rpm disks. For random, non-sequential reads, either a RAID 5 or a RAID 1+0 configuration can be used.

Sequential Environments

For sequential environments such as a DSS database or a high-performance technical computing(HPTC) application, maintain a 1:14 ratio between controllers and large-capacity drives—that is, you install only disk trays with controllers or 2x2 configurations of the Sun StorEdge 6020 array using 73-GB or 146-GB disks—to help ensure adequate bandwidth and help reduce the potential for channel saturation.

RAID Levels

RAID 0

The RAID 0 level, because of its lack of redundancy, is not usually recommended for the Sun StorEdge 6020 array. Use it for high-speed streaming of large file reads—for example, video—of non-critical data which is easily available elsewhere within the organization.

RAID 1+0

Because the data is mirrored, half the capacity of the assigned drives is used for online storage. For example, if the user creates a four-drive RAID 1+0 storage pool with 36-GB drives, the resulting usable data capacity is 72 GB. The advantage of RAID 1+0 (over simple RAID 1) is that the system can tolerate more than one non-adjacent drive failure. With simple RAID 1, two drive failures anywhere in the storage pool would kill the storage pool.

Use RAID 1+0 for mirroring the host operating system and/or application programs or for creating a high-traffic log volume.

RAID 5

In striping with rotated parity, both file data and parity data are evenly distributed across all drives in the storage pool. The minimum size for a RAID 5 disk group is three disks and the maximum size is 14 disks.

RAID 5 balances the optimization of performance, reliability and cost. Use this level for most applications which do not require the special characteristics of the above RAID levels.

Block Size

Block size is the size of the data unit being "striped" across the disks. There are five possible settings for the Sun StorEdge 6020 array—4 KB, 8 KB, 16 KB, 32 KB, or 64 KB—one of which should be matched to the I/O size of the application. In general, transaction-processing environments—for example, most database, ISP, and EPR applications—use a small I/O size and tend to benefit from using a 4-KB block size. Applications using large I/O sizes—such as decision support systems (DSS), high-performance computing (HPC), data warehousing, and imaging—tend to benefit from using a 64-KB block size. For latency-sensitive applications, such as OLTP applications, using a 16-KB block size is best. Applications using a medium I/O size generally fare best with a block size in the middle, so a 8-KB, 16-KB, or 32-KB setting is recommended.

The block size setting also determines internal settings in the controller—such as number of parallel XOR operations the controller can perform—which settings affect the self-tuning behavior of the array. This is the single most important "tuning knob" for the array.

Optimizing Adaptive Cache

For small-block random writes (OLTP), the minimum write size from host into the cache is a segment—1/8 of a Sun StorEdge 6020 array units block. If a host write is smaller than one segment, then the entire segment must be read from disk and modified by the write. The block is held in cache as long as possible to allow subsequent random writes of additional segments in the same block to occur. When the entire block is filled, it can be written as a single atomic write to disk, thus consolidating eight host writes into a single disk write.

Even when less than an entire block must be written, if the segments are contiguous, they can be written as a single atomic write to disk, without having to read the remainder of the block from disk into cache. If, for some reason—for example, because the 80 percent write threshold was reached—one or more non-contiguous segments in a block must be written, then a read/modify/write sequence of the entire block must be performed.

The algorithm of segment write with block writes from host to disk is especially crucial to RAID 5 partial stripe write performance. In addition, it benefits RAID 1(1+0) write performance.

- **Large-block sequential writes**

  For large-block sequential writes, the ideal host I/O size for large-block sequential writes is equal to either the Sun StorEdge 6020 array unit's block size or to an integer multiple of Sun StorEdge 6020 array unit's block size. This allows full block atomic writes to be performed. If RAID 5 is being used, this further allows for parity to be calculated in atomic units of segments.

  Another feature of Sun StorEdge 6020 array unit's adaptive cache is that even with write-behind mode in effect, large-block sequential writes are treated as write-though data. There is little advantage to holding large-block sequential writes in cache because they are unlikely to be read again soon as cache hits.

  Furthermore, large sequential I/O tends to saturate cache, eventually resulting in the same effect as write-through mode, but meanwhile monopolizing the cache at the expense of other random I/O which might also be occurring. So when the Sun StorEdge 6020 array detects large-block sequential I/O, it writes to disk before sending an acknowledgment to the host, thus freeing up the same block for the next sequential write, and keeping the remainder of the cache available for random writes.

- **Small-block sequential reads**

  For small-block sequential reads, the cache read-ahead parameter is configurable. If more than two host I/O blocks—*note, not Sun StorEdge 6020 array blocks*—are read consecutively, then the entire array block which holds those I/O blocks is read into cache. The default setting is "on, " indicating read-ahead mode is enabled. The read-ahead parameter can be viewed and set from any administrative CLI or GUI tool which has write access to the Sun StorEdge 6020 array.

  Examples of small-block sequential reads are:

  - **Example 1:** Sun StorEdge 6020 array with a 64-KB block size, 8-KB host I/O block size, read-ahead enabled. Two consecutive 8-KB blocks are read by the host, causing two 8-KB array segments of a 64-KB block to be read into cache. Because read-ahead is enabled, the Sun StorEdge 6020 array reads the remainder of its 64-KB block (that is, six more 8-KB segments) into cache.
  - **Example 2:** Sun StorEdge 6020 array with a 64-KB block size, 2-KB host I/O block size, read-ahead enabled. Two consecutive 2-KB blocks are read by the host, causing one 8-KB 6020 segment, four host I/O blocks, to be read into cache. Because read-ahead is enabled, the array reads the remainder of its 64-KB block (that is, seven more 8-KB segments, 28 more host I/O blocks) into cache. Thus, a total of 32 host I/O blocks is read into cache: the two requested blocks plus 30 more.

- **Example 3:** Sun StorEdge 6020 array with a 64-KB block size, 64-KB host I/O block size, read-ahead enabled. Two consecutive 64-KB blocks are read by the host, causing two entire 64-KB blocks to be read into cache. Even though read-ahead is enabled, the array does not read any additional data into cache, because there is no remaining portion of a Sun StorEdge 6020 array block to read.

Note: *If the host I/O block size multiplied by two is as large or larger than the Sun StorEdge 6020 array block size, then the read-ahead parameter has no effect, and read ahead never occurs, even if the read-ahead parameter is enabled.*

Disabling Split-Loop Mode Capability of the Sun StorEdge 6020 Array

The split-loop mode in the Sun StorEdge 6020 array is enabled by default to help improve the back end performance of the Fibre Channel loops. During boot up of the Sun StorEdge 6020 array, there is no splitting of loops. Split loop is enabled once the health of the array is verified. The split loop mapping of drives to one of the three loops is depicted in Figure 10.

The split loop can be disabled by modifying some system parameters. Splitting one of the loops allows an array's back-end drives to have performance (bandwidth) of 300 MB/seccond as compared to the usual 200 MB/second performance..

In non-split-loop mode, the 28 disk drives (of a 2x2 configuration) can be accessed through each unit interconnect card. In other words, 28 drives can be accessed through Fibre Channel Loop A and 28 through Fibre Channel Loop B. In contrast, using split-loop mode, Loop A is split into two loops so that 10 drives are communicated through Loop A1, 10 drives through Loop A2 and 8 through Loop B.

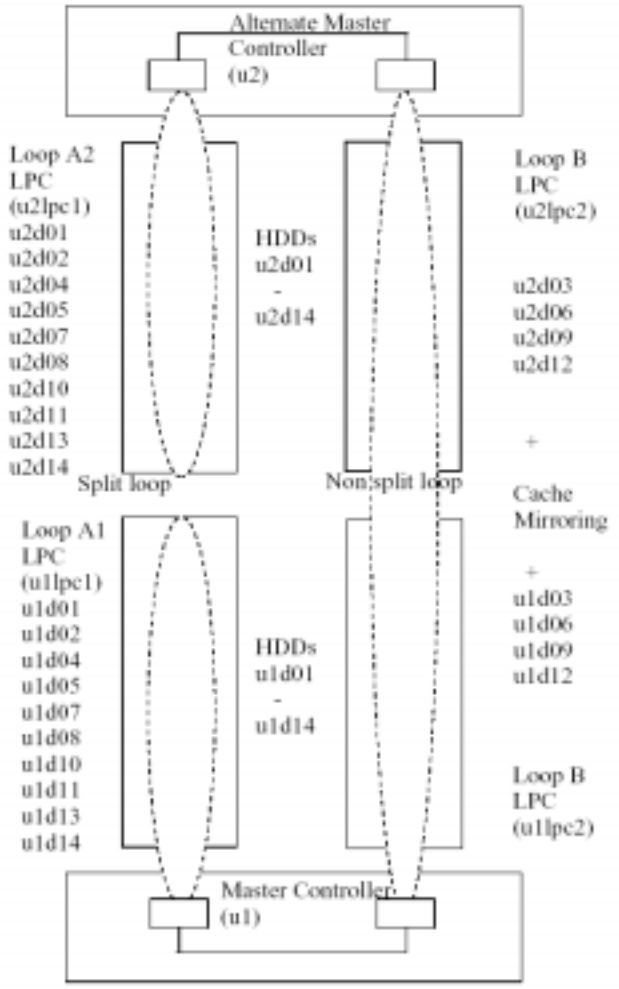


Figure 10. Sun StorEdge 6020 array, split-loop mode

High-Availability Connectivity

To achieve high availability for this system, each of the hosts connecting to it must provide paths to both controllers of the Sun StorEdge 6020 array's trays for redundancy. In addition, each host must use multipathing software on the host so that availability is not lost due to a Sun StorEdge 6320 system internal failure along one of the paths.

Front-End Switches

Front-end switches do NOT need to be used in the Sun StorEdge 6320 system.

Configurations with front-end switches allow for direct host connectivity without requiring any additional switches or connection into a SAN. The primary customer benefit is "soft recabling," allowing the administrator to easily reconfigure storage without having to manually re-cable. Front-end switches also allow for connectivity into a SAN, where the switches are acting as "edge" switches in the SAN.

Configurations without front-end switches allow for connectivity into a SAN or directly to hosts through the system patch panel.

If the customer opts to use switches within the Sun StorEdge 6320 system's rack, it is required that the switches be managed through the applicable host-based switch management software. The Storage Service Processor included with the Sun StorEdge 6320 system does not monitor, diagnose, or manage these switches.

Switch configurations are not saved by the Storage Service Processor. It is highly recommended that the user document switch configuration settings, in case of a failure that would require a rebuild of the switch configuration.

Consideration should be given to future growth of both external ports and additional storage arrays. Larger switches can also be used or external fan out switches to allow more connectivity. Figure out the number of hosts to attach, the number of storage arrays needed, plan for growth and then use the tables below to pick 8 or 16-ports and whether external or larger switches are required.

Note: *If the customer plans on using two cabinets (either at initial installation or post-install) and needs front-end switches, it is highly recommended that the customer use 16-port switches, especially if they need many Sun StorEdge 6020s in the system.*

Front-End Switches Being Used	Number of HA controllers (SE6020) in Base and Expansion Cabinets	Number of Available Ports[24] (per switch) for SAN/Host Connections
8-port	1	7
8-port	2	6
8-port	3	5
8-port	4	4
8-port	5	3
8-port	6	2
8-port	7[25]	1
16-port	1	15
16-port	2	14
16-port	3	13
16-port	4	12
16-port	5	11
16-port	6	10
16-port	7	9
16-port	8	8
16-port	9	7
16-port	10	6
16-port	11	5

[24]May require additional Fibre Channel cables and reconfiguration of the switches.

[25]Note that there cannot be more than seven controller pairs in the base and expansion cabinets if using 8-port front-end switches. There are not enough ports on the front-end switches to support more than seven controller pairs.

Note: In order to ensure maximum bandwidth available to host applications, the amount of host-to-array connections on a given switch should balance. To achieve such balance, an 8-port switch should only be deployed where four Sun StorEdge 6020 array controllers or less are needed. 16-port switches should be used for up to eight Sun StorEdge 6020 array controllers. For nine to eleven Sun StorEdge 6020 array controller configurations, larger (24+ ports) switch sizes are recommended for best throughput.

For consolidated storage deployments, maximizing performance is less of a consideration and a certain amount of bandwidth oversubscription is commonly tolerated. Here several host connections *share* a controller port. The number of hosts that feasibly may share one controller ports depends on the applications running on the hosts, host architecture, and I/O patterns. Since detailed I/O profiling of several hosts tend to be time consuming and complex, common guidelines for controller to host ratios have been developed. Please note that these ratios are only meant as a tool to give you a general sense of how many controllers need to be ordered for a given 6320 deployment.

Controller port to host port ratios:

Intel Platform/Windows NT/Windows 2000/Linux:	10 hosts per controller port
Sun Platform/Solaris – generic Unix:	4 hosts per controller port

As an example of such storage consolidation could be five Sun StorEdge 6020 arrays connected to dual external 32-port fabrics with a host mix of 30 Intel and 8 Sun-based hosts.

A full contingent of eleven Sun StorEdge 6020 array controllers in one Sun StorEdge 6320 system deployment would yield 11*4 = 44 Sun hosts or 11*10 = 110 Intel hosts, respectively. Any mix interpolated between these outer limits would still adhere to the ratios described above.

Volume Failover Mechanisms

Typically, customers will use one of the following multipathing options.

Option #	Use VERITAS Volume Manager with DMP (VxVM/DMP)?	Use Sun's Multipathing Software (for SPARC-based Solaris hosts) or SSTM 3.0 (for non-Solaris hosts)
1	Yes	No
2	Yes	Yes
3	No	Yes

Option #1 — Using VxVM/DMP but not Sun's Multipathing Software

This option is NOT recommended. It is highly recommended that customers use either Option #2 or Option #3.

VERITAS Volume Manager with DMP (VxDMP) only works in single host per 6020 array configuration. If two hosts try to share a Sun StorEdge 6020 array, then there may be "ping-ponging"[26] in the event there is ever a failure of a host path between the host and the switch. This is because DMP does not support explicit LUN failover (ELF) mode on the arrays used within the Sun StorEdge 6320 system.

[26]There is no mechanism for a host to determine whether the current online path is a primary or secondary path. In a multi-host configuration, if one of the host loses the primary path to a storage pool, then it causes a continuous failover situation, wherein the host losing the primary path causes a failover to the secondary path and other hosts cause a failover back to the primary path.

Option #2 — Using VxVM/DMP and Sun's Multipathing Software

In this scenario, Sun's multipathing software (for both Solaris and non-Solaris hosts) uses explicit LUN failover (ELF) and hides all the paths from VxVM/DMP. VxVM/DMP does not need to perform multipathing and failover—that is, DMP has no role. Sun's multipathing software performs the path failovers and allows several hosts to share a storage pool. VxVM/DMP provides additional host based control over volumes accessed by the host.

Option #3 — Using Sun's volume management software and only Sun's Multipathing Software

This option is virtually the same as Option #2 in that Sun's multipathing software performs the path failovers and allows several hosts to share a storage pool. Volumes are accessed directly and can also be managed with Solstice Diksuite 4.2.1 for systems running the Solaris 8 OE and Solaris Volume Manager for hosts running the Solaris 9 OE.

As mentioned before, either Option #3 or Option #2 is highly recommended.

Adding Drives to Depopulated Trays

All trays for the Sun StorEdge 6320 system are shipped pre-configured from the factory with one RAID 5 storage pool and a hot-spare in the 14th bay of the tray, regardless of the number of drives that were ordered in the tray. The 14th bay can be reconfigured and used as a data drive if hot-sparing is not required. A disk tray can have either one or two storage pools. Storage pools must be contiguous within the tray and disk drives must be filled from left to right, slot 14 being the only exception.

Adding Drives/One Existing Storage Pool Per Tray

If the disk tray has less than 14 drives and one storage pool is used, additional drives can be added at a later date to create a second storage pool dynamically and without the need for reconfiguration of the eisting storage pool. If the configuration requires disk drives to be added to the existing pool it must first be removed, causing the data wihtin the pool to be lost, and then recreated.

Adding Drives/Two Existing Storage Pools Per Tray

If the disk tray has less than 14 drives and two storage pools are used, additional drives cannot be added unless an existing storage pool is removed. In some cases both pools may need to be removed to meet customer configuration requirements. The removal of a storage pool will cause data within the pool to be lost.

Recommendations

Based on the aforementioned information, it is highly recommended that disk trays for the Sun StorEdge 6320 system be ordered with one of the following drive combinations:

- Seven drives
  - Six drives for storage pool #1 and one hot-spare drive in bay 14
  - To avoid having to backup, reconfigure and restore existing data, it is recommended to ***plan*** for two storage pools per tray when using depopulated trays. Although adding drives in increments of one to a depopulated tray is supported, it is highly recommended that additional drives be added to the tray as the second and last storage pool for the tray.

- Additional drives should be ordered in increments of seven so that they can be added non-disruptively to the disk tray as storage pool #2.

- Fourteen drives
  - Six or seven drives for storage pool #1, six or seven drives for storage pool #2, one hot-spare drive in bay 14
  - Thirteen drives for storage pool #1 with one hot-spare drive in bay 14

Drive Sizes Within Trays

Although two storage pools within a tray can have mixed capacity hard disk drives, it is recommended that the same capacity and spindle speed disk drives be used within each tray and each array group: 2x2, 2x4, or 2x6. It is also recommended that disk drives in the two controller trays have the same number of drives with the same capacity and spindle RPM speed.

RAID 5 Considerations

One or Two Storage Pools Per Tray

Choosing the number of storage pools per tray when using RAID 5 storage pools requires balancing considerations of capacity, performance, and availability.

Using only one storage pool in a tray provides better performance over two pools because of the additional administrative overhead required for managing two pools. However, one storage pool requires a RAID 5 stripe of at least thirteen disks. A failure of one of those disks can result in twice the reconstruct time, the time the storage pool is in a vulnerable state because the subsequent failure of another drive within the pool causes data loss, than if there were two storage pools of only six or seven disks. Furthermore, using smaller drives in a RAID 5 stripe further decreases the reconstruct time.

Reconstruction Rate

By default, the reconstruction rate is set to medium for RAID 5.

The reconstruction rate can be set to low, medium, or high.

This setting controls how much reconstruction I/O the controller can perform between servicing host I/Os. At no time is all I/O activity completely halted. Setting the reconstruction rate parameter to medium or low allows for more I/O activity during rebuild, which increases the time period it takes to perform a complete rebuild. The default setting of medium is a good compromise between acceptable performance to the host and time to completely reconstruct the data which is also the window of vulnerability to a catastrophic double-failure.

At the extremes of low and high, the controller is almost entirely dedicated to serving host I/O in degraded mode or reconstructing lost data onto a properly working disk.

If the reconstruction time needs to be as short as possible and severely degraded performance during that time is acceptable, the reconstruction rate should be set to high. If host performance needs to be as high as possible and reconstruction time is not important, the reconstruction rate should be set to low.

It is highly recommended that the default setting of medium be used unless the application has a strong compelling reason to use another setting. Remember that during the time a RAID 5 set is running with one drive short, it is vulnerable to data loss due to the failure of one more drive, and performance is negatively impacted during this time as well. It is important to restore the stripe to full capacity and

functionality as quickly as possible, although it is important to realize that in order for this to occur, I/O activity can be significantly affected.

Remote Lights-Out Power Management

The remote lights-out power management feature allows the user to remotely shut down the entire system—that is, shut down power to all components within the system. If using this aspect of the feature, however, it cannot be restored remotely. The user has to physically turn on the power to the rack. This feature is primarily for moving the system to a new physical location.

Compatible Software

The following software is compatible with the Sun StorEdge™ 6320 system.

Sun™ Software

- Sun StorEdge™ Performance suite (QFS 4.0 or later)
- Sun StorEdge™ Utilization suite (SAM-FS 4.0 or later)
- Sun StorEdge™ Availability Suite 3.1
- Sun StorEdge™ Resource Management suite
- Sun StorEdge™ Enterprise Storage Manager software 1.2
- Sun StorEdge™ Network Data Replicator software 2.0, or later
- Sun StorEdge Traffic Manager (SSTM) software 3.0 for multipathing management
- Sun™ Cluster 3.0 software, update 3[27] (with Solstice DiskSuite™ software)
- Sun Cluster 3.1 software (with Solstice DiskSuite software and VxVM 3.5)
- Sun StorEdge™ Enterprise Backup software 7.0
- Solstice™ Backup (SBU) 6.1.X
- Solstice™ DiskSuite 4.2 and 4.2.01.00 software, or later
- Sun StorEdge™ Data Management Center 3.0, or later
- Solstice DiskSuite™ 4.2.1 software (in conjunction with Solaris™ 8 Operating Environment)
- Solaris Volume Manager software (embedded in Solaris 9 Operating Environment)
- Sun StorEdge SAN software release 4.2

Third-Party Software

- VERITAS NetBackup (VxNBU) 4.5, or later
- VERITAS Volume Manager with DMP (VxVM/DMP) 3.5, or later
- VERITAS File System (VxFS) 3.5, or later

VERITAS Volume Manager ASL Software Packages

VERITAS Volume Manager 3.5 MP1 (Patch 01 for VxVM 3.5) provides support for the Sun StorEdge 6320 system in the form of Array Support Library (ASL) software packages. The ASL packages and related documentation can be obtained from the Sun Download Center site at:

`http//www.sun.com/software/download/`

[27]Only Solaris™ Volume Manager software can be used with Sun Cluster 3.0 software. When Sun Cluster 3.1 software is supported on the Sun StorEdge 6320 system, either VERITAS Volume Manager 3.5 or Solaris Volume Manager software can be used.

Ordering Information

Ordering information and part numbers for the Sun StorEdge™ 6320 system are provided in this section. Note that documentation does not ship with the Sun StorEdge 6320 products.

Shipping Configurations

The basic Sun StorEdge 6320 System base cabinet includes the following:

- (1) SSRR Global Telco Adaptor Kit
- (1) USB Flash Disk
- (1) USB Male-Male cable, 0.9 meter
- (2) 15-meter LC-LC Fibre Channel cable per cabinet
- (3) 6-meter RJ45-RJ45 Ethernet cable per cabinet
- (1) “START HERE” Guide
- Pre-wired Fibre channel cables, Ethernet cables and power cords
- Pre-installed rack rails for storage modules
- A country kit with the appropriate power cords is added by the WEBDESK depending on the destination of the shipment

The basic Sun StorEdge 6320 System, expansion cabinet includes the following:

- (2) MTP – MTP cables
- (1) 10-meter RJ45 ethernet crossover cable
- (2) DB9F to DM9M cables per cabinet
- Pre-wired Fibre Channel cables, Ethernet cables and power cords
- Pre-installed rack rails for storage modules
- A country kit with the appropriate power cords is added by the WEBDESK depending on the destination of the shipment

The basic Sun StorEdge 6020 storage modules array includes:

- Dual controller trays: two controllers total, one hardware controller card per tray
- Expansion tray: NO controller card
- Minimum of 7 drives per tray, maximum of 14 drives per tray
- Rack ready, and rack mounted configurations
- Sun StorEdge 6000 Family Host Installation software
- Two-year on-site warranty
- All the *rack ready and ATO rack mounted* configurations include the appropriate number of unit interconnect cables (loop card cables), as listed below:
  - Sun StorEdge 6020-HA, 2x2 controller trays — 2 interconnect cables
  - Sun StorEdge 6020-HA, 0x2 expansion trays — 4 interconnect cables

Storage Services package for the StorEdge 6320 Systems

The following value-added software will be included automatically by Webdesk.

Part Number	Title and Shipping Configuration	StorEdge 6320 system with storage modules	StorEdge 6020 2x2	StorEdge 6020 0x2
NCSSS-210-9FN9	Sun StorEdge 6000 Family Host Installation software Media, on-line Documentation (no charge when purchased with Sun StorEdge 6120 arrays)	Yes	Yes	No
NEMIS-120-2FN9	Sun StorEdge(TM) Enterprise Storage Manager 1.2 Media, on-line Documentation and 3TB RTU license (no charge when purchased with Sun StorEdge 6020 storage modules)	No	Yes	No
NEMIS-120-3FN9	Sun StorEdge(TM) Enterprise Storage Manager 1.2 Media, on-line Documentation and 6TB RTU license (no charge when purchased with Sun StorEdge 6320 systems)	Yes	No	No
NAVIS-310-1FNS	Sun StorEdge(TM) Availability Suite 3.1 Media, on-line Documentation and 1TB RTU license (no charge when purchased with Sun StorEdge 6320 Systems or Sun StorEdge 6020 storage modules – one per 2x2)	Yes	Yes	No

Marketing Part Numbering Scheme

Example part number = XTA6320-00-122-S01

X = X-option or no X for factory-configured system

T = Storage family product

A = Product revision number: A. A is the first generation of the Sun StorEdge 6320 product.

6320 = Product class/model number: Sun StorEdge 6320 storage system

0 = No virtualization

0 = Number of switches: 0 = no switches, 3 =r two Sun 2-Gb FC 16-port switches

1 = Quantity of controller boards

22 = Quantity of control unit/component group, where first digit is the total number of control units in a group second digit is the total number of trays in a group, as follows:

22 = 2 controller units, 2 trays total, 2x2

24 = 2 controller units, 4 trays total, 2x4

26 = 2 controller units, 4 trays total, 2x6

S = Hard disk drive types: S = 36-GB 15000-rpm drives; T = 73-GB 10000-rpm drives; U = 146-GB 10000-rpm drives

01 = Capacity in whole TB

Part Number	System Components	Raw Capacity
TA6320-0	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • Zero (0) Sun StorEdge 6020 arrays • One (1) Service Processor accessory tray	0 TB
XTA6320-00-122-S01	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x2) fully populated with 36-GB drives • One (1) Service Processor accessory tray	1 TB
XTA6320-03-122-S01	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x2) fully populated with 36-GB drives • One (1) Service Processor accessory tray • One (1) pair 16-port FC front-end switches	1 TB
XTA6320-00-124-S02	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x4) fully populated with 36-GB drives • One (1) Service Processor accessory tray	2 TB
XTA6320-03-124-S02	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x4) fully populated with 36-GB drives • One (1) Service Processor accessory tray • One (1) pair 16-port switches	2 TB
XTA6320-00-122-T02	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x2) fully populated with 73-GB drives • One (1) Service Processor accessory tray	2 TB
XTA6320-03-122-T02	• One (1) rack • One (1) Ethernet hub • One (1) Storage Service Processor • One (1) Sun StorEdge 6020 array (2x2) fully populated with 73-GB drives • One (1) Service Processor accessory tray • One (1) pair 16-port switches	2 TB
TA-EXPCAB-060	• One (1) rack • One (1) Ethernet hub	0 TB

Sun StorEdge 6020 Array Part Numbers, Ordering Rules

- Use the following table as a guide for ordering trays from the subsequent table.

- Build 2x2, 2x4, and 2x6 configurations from combination of 0x2 and 2x2 part numbers in the subsequent table.

ATO or X-Option Rack-Ready (RR) or Rackmounted (RM) Fixed Configuration (FC) or Building Block (BB)	Order When...
• X-Option • RR • FC	... installing trays (***in the field***) after original sale of the Sun StorEdge 6320 system and you do ***not*** need to customize what goes into the trays
• ATO • RR • BB	... installing trays (***in the field***) after original sale of the Sun StorEdge 6320 system and you need to customize what goes into the trays
• ATO • RM • FC	... needing trays to be ***factory-installed*** in the Sun StorEdge 6320 and you do ***not*** need to customize what goes into the trays
• ATO • RM • BB	... needing trays to be ***factory-installed*** in the Sun StorEdge 6320 and you need to customize what goes into the trays

Sun Part Number	ATO/X-Option RM/RR FC/BB	Need to Order Add'l Drives?	Number of Controllers	No. of Trays	No. of Drives	Drive Size/RPM	Raw Capacity
XTA6020R02A0S504	• X-Option • RR • FC	No	0	2	14	36 GB 15000 rpm	504 GB
XTA6020R02A0T1022	• X-Option • RR • FC	No	0	2	14	73 GB 10000 rpm	1 TB
XTA6020R02A0U2044	• X-Option • RR • FC	No	0	2	14	146 GB 10000 rpm	2 TB
XTA6020R02A0S1008	• X-Option • RR • FC	No	0	2	28	36 GB 15000 rpm	1 TB
XTA6020R02A0T2044	• X-Option • RR • FC	No	0	2	28	73 GB 10000 rpm	2 TB
XTA6020R02A0U4088	• X-Option • RR • FC	No	0	2	28	146 GB 10000 rpm	4 TB
XTA6020R22A1S504	• X-Option • RR • FC	No	2	2	14	36 GB 15000 rpm	504 GB

Sun Part Number	ATO/X-Option RM/RR FC/BB	Need to Order Add'l Drives?	Number of Controllers	No. of Trays	No. of Drives	Drive Size/RPM	Raw Capacity
XTA6020R22A1T1022	• X-Option • RR • FC	No	2	2	14	73 GB 10000 rpm	1 TB
XTA6020R22A1U2044	• X-Option • RR • FC	No	2	2	14	146 GB 10000 rpm	2 TB
XTA6020R22A1S1008	• X-Option • RR • FC	No	2	2	28	36 GB 15000 rpm	1 TB
XTA6020R22A1T2044	• X-Option • RR • BB	No	2	2	28	73 GB 10000 rpm	2 TB
XTA6020R22A1U4088	• X-Option • RR • BB	No	2	2	28	146 GB 10000 rpm	4 TB
TA6020R02A0	• ATO • RR • BB	Yes	0	2	0	N/A	0 TB
TA6020R22A1	• ATO • RR • BB	Yes	2	2	0	N/A	0 TB
TA6020M02A0S504	• ATO • RM • FC	No	0	2	14	36 GB 15000 rpm	504 GB
TA6020M02A0T1022	• ATO • RM • FC	No	0	2	14	73 GB 10000 rpm	1 TB
TA6020M02A0U2044	• ATO • RM • FC	No	0	2	14	146 GB 10000 rpm	2 TB
TA6020M02A0S1008	• ATO • RM • FC	No	0	2	28	36 GB 15000 rpm	1 TB
TA6020M02A0T2044	• ATO • RM • FC	No	0	2	28	73 GB 10000 rpm	2 TB
TA6020M02A0U4088	• ATO • RM • FC	No	0	2	28	146 GB 10000 rpm	4 TB
TA6020M22A1S504	• ATO • RM • FC	No	2	2	14	36 GB 15000 rpm	504 GB

Sun Part Number	ATO/X-Option RM/RR FC/BB	Need to Order Add'l Drives?	Number of Controllers	No. of Trays	No. of Drives	Drive Size/RPM	Raw Capacity
TA6020M22A1T1022	• ATO • RM • FC	No	2	2	14	73 GB 10000 rpm	1 TB
TA6020M22A1U2044	• ATO • RM • FC	No	2	2	14	146 GB 10000 rpm	2 TB
TA6020M22A1S1008	• ATO • RM • FC	No	2	2	28	36 GB 15000 rpm	1 TB
TA6020M22A1T2044	• ATO • RM • FC	No	2	2	28	73 GB 10000 rpm	2 TB
TA6020M22A1U4088	• ATO • RM • FC	No	2	2	28	146 GB 10000 rpm	4 TB
TA6020M02A0	• ATO • RM • BB	Yes	0	2	0	N/A	0 TB
TA6020M22A1	• ATO • RM • BB	Yes	2	2	0	N/A	0 TB

Disk Drives

Part Number	Title and Shipping Configuration	Order When...
X6867A	36GB/15K FC HDD	... installing these drives (***in the field***) after original sale of the Sun StorEdge 6320 system
6867A	36GB/15K FC HDD	... installing these drives (***in the field***) after original sale of the Sun StorEdge 6320 system
X6815A	73GB/10K FC HDD	... installing these drives (***in the field***) after original sale of the Sun StorEdge 6320 system
6815A	73GB/10K FC HDD	.. needing these drives to be ***factory-installed*** in the Sun StorEdge 6320
X6817A	146GB/10K FC HDD	.. needing these drives to be ***factory-installed*** in the Sun StorEdge 6320
6817A	146GB/10K FC HDD	.. needing these drives to be ***factory-installed*** in the Sun StorEdge 6320

Options for Sun StorEdge 6020 Arrays

Part Number	Title and Shipping Configuration	Order When...
X6888A	RAID controller card	.. converting an expansion tray to a controller tray (***in the field***)

No Charge Options — Software

Part Number	Title and Shipping Configuration
NCSSS-210-9FN9	Sun StorEdge 6000 Family Host Installation software 2.1
NEMIS-120-3FN9	Sun StorEdge Enterprise Storage Manager 1.2 Media, Documentation and 6-TB RTU (no charge when purchased with Sun StorEdge 6320 system)
NAVIS-310-1FNS	Sun StorEdge Availability Suite 3.1 Media, Documentation and 1-TB RTU (no charge when purchased with the Sun StorEdge 6320 system)

Options — Power Cords

Part Number	Title and Shipping Configuration	Category
X3858A *(X = Field Install)*	U.S./Canada power cord for Sun StorEdge expansion cabinet (NEMA L6-30P plug)	To be installed in the field into Sun StorEdge 6320 systems
X3859A *(X = Field Install)*	International power cord for Sun StorEdge expansion cabinet (IEC 309, 32A, 250V plug)	To be installed in the field into Sun StorEdge 6320 systems

Options — Switches/GBICs

Part Number	ATO or X-Option	Title
Sun StorEdge Network 2-Gb FC Switches		
SG-XSW8-2GB	X-option	2-Gb Sun StorEdge network FC switch-8 (no SFPs included)
SG-XSW16-2GB	X-option	2-Gb Sun StorEdge network FC switch-16 (no SFPs included)
SG-SW16PAIR-2Gb	ATO	Pair of 2-Gb Sun StorEdge network FC switch-16 (32 SFPs included)
Brocade Silkworm Switches		
SG-XSWBRO3200	X-option	Brocade Silkworm 3200 8-port switches (no SFPs included)
SG-XSWBRO3800	X-option	Brocade Silkworm 3800 16-port switches (no SFPs included)
SG-XSWBRO3200RK	X-option	Brocade Silkworm 3200 rack kit
SG-XSWBRO-3800EXF	X-option	Brocade Silkworm 3800 Extended Fabrics software
SG-XSWBRO-3800RSW	X-option	Brocade Silkworm 3800 Remote Switch software
SG-XSWBRO-3800TRK	X-option	Brocade Silkworm 3800 Trunking software
SG-XSWBRO-3800ULT	X-option	Brocade Silkworm 3800 Ultra bundle (TRK, EXT, and RSW)
SG-XSWBRO-FMG	X-option	Fabric Manager software for Brocade Silkworm switches
SG-XSWBRO-12000-01	X-option	Country Kit — North America (Brocade switches)
SG-XSWBRO-12000-02	X-option	Country Kit — UK/Ireland (Brocade switches)
SG-XSWBRO-12000-03	X-option	Country Kit — Australia/New Zealand (Brocade switches)
SG-XSWBRO-12000-04	X-option	Country Kit — Europe (Brocade switches)
SG-XSWBRO-12000-05	X-option	Country Kit — Other (Brocade switches)
SFP/GBIC		
XSFP-LW-2GB	X-option	Small form pluggable 2-Gbit Fibre Channel transceiver, longwave
XSFP-LW-2GB-4PK	X-option	Small form pluggable 2-Gbit Fibre Channel transceiver, longwave, 4-pack
XSFP-SW-2GB	X-option	Small form pluggable 2-Gbit Fibre Channel transceiver, shortwave
XSFP-SW-2GB-4PK	X-option	Small form pluggable 2-Gbit Fibre Channel transceiver, shortwave, 4-pack

Options — Host Bus Adapters

Part Number	ATO or X-Option	Title
X6767A	X-option	Sun StorEdge 2-Gb PCI single Fibre Channel network adapter
X6768A	X-option	Sun StorEdge 2-Gb PCI dual Fibre Channel network adapter
X6799A	X-option	Sun StorEdge PCI single Fibre Channel network adapter
X6727A	X-option	Sun StorEdge PCI dual Fibre Channel network adapter
X6748A	X-option	Sun StorEdge cPCI dual Fibre Channel network adapter
X6757A	X-option	Sun StorEdge 1-Gb SBus dual Fibre Channel network adapter

Options — Sun StorEdge Traffic Manager Software for Non-Solaris Operating Environments

Part Number	Title and Shipping Configuration
MPDIN-300-99YS	Sun StorEdge Traffic Manager 3.0 Media Kit for Windows 2000/NT
MPDIB-300-99YS	Sun StorEdge Traffic Manager 3.0 Media Kit for AIX
MPDIH-300-99YS	Sun StorEdge Traffic Manager 3.0 Media Kit for HP-UX 11.0
MPDIN-LCO-992S	Sun StorEdge Traffic Manager 1 RTU for Windows 2000/NT (1 RTU license)
MPDVN-LCO-992S	Sun StorEdge Traffic Manager 5 RTU for Windows 2000/NT (5 RTU licenses)
MPDYN-LCO-992S	Sun StorEdge Traffic Manager 25 RTU for Windows 2000/NT (15 RTU licenses)
MPDIH-LCO-992S	Sun StorEdge Traffic Manager 1 RTU for HP-UX (1 RTU license)
MPDVH-LCO-992S	Sun StorEdge Traffic Manager 5 RTU for HP-UX (5 RTU license)
MPDIB-LCO-992S	Sun StorEdge Traffic Manager 1 RTU for AIX (1 RTU license)
MPDVB-LCO-992S	Sun StorEdge Traffic Manager 5 RTU for AIX (5 RTU license)

Options — Cables

Part Number	Title and Shipping Configuration
X9732A	2-meter LC-to-LC FC optical cable (used with 2-Gb switches/HBAs)
X9733A	5-meter LC-to-LC FC optical cable (used with 2-Gb switches/HBAs)
X9734A	15-meter LC-to-LC FC optical cable (used with 2-Gb switches/HBAs)
X9721A	0.4-meter LC-to-SC FC optical cable (used with 1-Gb switches/HBAs)
X9722A	2-meter LC-to-SC FC optical cable (used with 1-Gb switches/HBAs)
X9723A	5-meter LC-to-LC FC optical cable (used with 1-Gb switches/HBAs)
X9724A	15-meter LC-to-LC FC optical cable (used with 1-Gb switches/HBAs)

Options — Services

Further information about these services can be found in the section entitled "Support Services."

Part Number	Title
EIS-ARR-SYS	Sun StorEdge Array System Installation Service
EIS-ARRAY-TRAY	Sun StorEdge Tray Installation Service
RR-START	Sun StorEdge Remote Response Installation
ES-343	Sun StorEdge 6320 and 6020 Array Installation and Administration

Ordering Rules

Ordering Rules — General

- The Sun StorEdge 6320 system has a service notification process[28] associated with it, which is basically pre-installation planning for service training, FRU sparing, configuration, and remote support (SSRR) site preparation. By completing this process, Sun customers are more likely to have a smooth and successful installation and their first impression of Sun should be positive. (Resellers should work with their direct sales counterpart in Sun to complete this process.) The URLs to initiate this process are:
  - `http://mcso.central:7080` (US)
  - `http://mcso.singapore:8080` (APAC)
  - `http://mcso.holland:8080` (EMEA)
  - `http://mcsoscb.central:8080` (International)
- All ATO configurations for this product MUST be ordered through Sun's configurator tools (accessible through WEBDESK and Partner WEBDESK).
- **Always order** NCSSS-210-9FN9 with every Sun StorEdge 6320 system order. This is the host software which includes necessary drivers for multipathing, the thin scripting client/remote configuration CLI, etc.
- One of the following part numbers must be ordered to create the minimum configuration of a Sun StorEdge 6320 system:
  - TA6320-0
  - XTA6320-00-122-S01
  - XTA6320-03-122-S01
  - XTA6320-00-124-S02
  - XTA6320-03-124-S02
  - XTA6320-00-122-T02
  - XTA6320-03-122-T02

[28] **PLEASE NOTE: THE Sun StoreEdge 6320 SYSTEM WILL NOT BE SUBJECTED TO ANY HOLD IF THIS PROCESS IS INCOMPLETE.**

- Each of the aforementioned part numbers is required to have two power cords. Select on the basis of the country; there is a pulldown menu in the wizard. Use X3858A for U.S. and Canada. Use X3859A for the rest of the world. Assemble-to-Order (ATO) or "Factory Install" part numbers do this automatically based on the Product Distribution Center (PDC) that the product is shipped from.
- If none of the X-option Sun StorEdge 6320 part numbers meets customers' needs, the Sun StorEdge 6320 system can be customized using TA6320-0 and ATO Sun StorEdge 6020 array part numbers. X-option Sun StorEdge 6020 array part numbers cannot be factory-installed in a Sun StorEdge 6320 system. They can be added in the field (at the customer site).
- Only one expansion cabinet (TA-EXPCAB-060) can be added to the Sun StorEdge 6320 base cabinet.
- 36-GB, 73-GB, and 146-GB drives can be used in the Sun StorEdge 6320 system.

Sun StorEdge 6020 Array

- When ordering arrays for the Sun StorEdge 6320 system, think in terms of ordering tray sets and not parts, because this is the way it is laid out in the configurator tool and the only way it can get build instructions to Operations. In other words, concentrate on whether the customer needs 0x2, 2x2, 2x4 or 2x6, with which disk types, and however many drives. The tool will then generate the appropriate parts list and supply the build instructions to the factory.
- X-option Sun StorEdge 6020 array part numbers cannot be factory-installed in a Sun StorEdge 6320 system. They can be added in the field (at the customer site).
- A minimum of 7 drives must populate each tray that is used within the Sun StorEdge 6320 system. Anywhere from 7 to 14 drives can populate each Sun StorEdge 6020 array tray used in the Sun StorEdge 6320 system.
- A diskless SPUD-3 drive bracket is mandatory (and will be ordered automatically by the configurator tool) for every unused/empty drive slot in a tray.
- Only Sun StorEdge 6020 arrays with dual controllers can be used within the Sun StorEdge 6320 system. Sun StorEdge 6020 arrays that do not have any controllers can only be used to expand an array with two controllers. For example, if a 2x2 is in the Sun StorEdge 6320 system's base or expansion cabinet, it can be converted to a 2x4 or a 2x6 by ordering Sun StorEdge 6020 array expansion trays (same concept applies to a 2x4).
- Any combination of Sun StorEdge 6020 arrays—2x2, 2x4, 2x6—can be used within both the base and expansion cabinets of the Sun StorEdge 6320 system.
- The maximum number of trays that can be used within the base cabinet is 10. The maximum number of trays that can be used within the base and expansion cabinets is 22.

Front-End Switches

- For customers that want front-end switches factory-installed, only Sun 2-Gb FC 16-port switches can be used. If customers would like to install Sun 2-Gb FC 8-port, Brocade 3200 (2-Gb FC 8-port), and Brocade 3800 (2-Gb FC 16-port), they must be installed in the field.
- The switches are provided with shortwave SFPs. The customer can replace the shortwave SFPs with longwave SFPs.

Installation Services

Sun highly recommends that customers purchase installation services for the Sun StorEdge™ 6320 system.

The Sun StorEdge Array System Installation Service provides the customer with installation and configuration of the Sun StorEdge 6320 system. This includes installation planning, site audit, system installation and configuration, acceptance testing, and system turnover.

Service	Part Number
Sun StorEdge℠ Array System Installation	EIS-ARR-SYS
Sun StorEdge Tray Installation	EIS-ARRAY-TRAY
Sun StorEdge Array Installation	EIS-ARRAY

For a new Sun StorEdge 6320 system, customers would order a combination of the following:

- Minimum quantity one (1) EIS-ARR-SYS
- Quantity one (1) EIS-ARRAY-TRAY for each tray that comes with the Sun StorEdge 6320 base cabinet (the price of the installation service will scale with the number of trays ordered)
- If the order includes an expansion cabinet, then quantity one (1) EIS-ARRAY-TRAY for each that tray that comes with the expansion cabinet

For a Sun StorEdge 6320 system already installed in the field, customers who need to expand capacity would order a combination of the following:

- Quantity one (1) EIS-ARRAY for each Sun StorEdge 6020 array
- Quantity one (1) EIS-ARRAY-TRAY for each additional tray

Some examples:

- If a customer orders XTA6320-00-124-S02, they would order quantity one (1) EIS-ARR-SYS and quantity four (4) EIS-ARRAY-TRAY.
- If a customer orders TA6320-0 and quantity three (3) XTA6020R22A1S504 (total of 6 trays in the base cabinet), they would order quantity one (1) EIS-ARR-SYS and quantity six (6) EIS-ARRAY-TRAY.
- If a customer wants to add quantity two (2) XTA6020R02A0S504 to an existing Sun StorEdge 6320 system (two additional arrays, four additional trays), they would order quantity one (1) EIS-ARRAY and quantity four (4) EIS-ARRAY-TRAY.

Enabling/activating SSRR is part of the Sun StorEdge Array System Installation Service. Purchase of the SSRR Installation Service (RR-START — a standalone service — see the next page for more details) is only necessary when the customer does not have SSRR enabled/activated during initial installation.

Any additional questions regarding this installation service can be directed to a local Sun Services representative.

Sun StorEdge Remote Response (SSRR) Service

The Sun StorEdge Remote Response (SSRR) service is offered by Sun Services. Enabling/activating this service is optional with the purchase of a Sun StorEdge 6320 system. It is included at no additional charge for Sun StorEdge 6320 systems for which the entire system is under Sun product warranty or for which the entire system is maintained at consistent service level of SunSpectrum Gold or SunSpectrum Platinum.

Sun StorEdge Remote Response Installation

Installation of the Sun StorEdge Remote Response Service (SSRR) is simply enabling/activating the service. All the necessary hardware for SSRR[29] comes standard with the Sun StorEdge 6320 system base cabinet.

Customers can request activation from Sun for the Sun StorEdge Remote Response service by following the instructions included with the Sun StorEdge 6320 product, or customers can purchase Sun StorEdge Remote Response Installation to have Sun coordinate activation and on-site planning the service on behalf of the customer.

Enabling/activating SSRR is part of the Sun StorEdge Array System Installation Service. Customers who purchase the Sun StorEdge Array System Installation do not need to purchase the SSRR Installation service. Purchase of the Sun StorEdge Remote Response Installation service (a standalone service) is only necessary when the customer does not have SSRR enabled/activated during the initial installation. In other words, if the customer decides at a later date to have SSRR enabled/activated by Sun Services, then they would purchase this service. If this is the case, it is highly recommended that customers purchase this service or have a Sun-trained representative perform this service.

The part number for this installation service is RR-START.

Enabling/activating SSRR consists of configuring the Sun StorEdge 6320 system to "phone home."

Enabling/activating SSRR includes the following:

- Site Preparation Review — Discuss analog phone line requirements and modem requirements (if applicable)
- On-Site Installation Planning — Verify analog phone line availability, and verify that the correct modem was purchased by customer (if applicable)
- Enable/activate SSRR service — Contact the remote Solution Center to initiate turn-on, assist the Solution Center with turn-on, and verify service initiation
- System Turnover — Sun turns the system over to the customer after the customer has verified that the SSRR service is functioning properly.

There is a one-time installation charge in order to set this service up (Sun StorEdge Remote Response Installation — part number RR-START), discussed earlier.

SSRR Eligibility

There are no separate monthly charges for SSRR service. Sun provides this service at no additional cost for certain Sun products maintained on Sun warranty or SunSpectrum Gold℠ or SunSpectrum Platinum℠ programs. Two SSRR service options are available, as follows.

[29]Unless the customer does not reside in a country in which the modem (that ships with the Sun StorEdge 6320 storage system) is supported. For further details, please see "Sun StorEdge Remote Response Service" in "Support Services".

Feature	Option 1: For Sun StorEdge 6320 Systems with Entire System on Product Warranty or on SunSpectrum Gold Program	Option 2: For Sun StorEdge 6320 Systems with Entire System on Product Warranty or on SunSpectrum Platinum Program
Remote monitoring — hours of coverage	24x7x365	24x7x365
Remote diagnosis and on-site dispatch notification	M-F, local extended business hours (12 hours per day)	24x7x365

Customers must maintain their entire Sun StorEdge 6320 system on warranty or SunSpectrum Gold or Platinum in order to receive SSRR.

Support Programs

The SunSpectrum℠ program is a service offering that allows customers to choose the level of service best suited to their needs. The SunSpectrum program provides a simple pricing structure in which a single fee covers support for an entire system, including related hardware and peripherals, the Solaris™ Operating Environment software, and telephone support for Sun™ software packages. Customers should check with their local Sun Services representative for program and feature availability in their areas.

For information specific to the Sun StorEdge 6320 system, refer to:

`http://www.sun.com/service/support/products/storage/`

SunSpectrum program support contracts are available both during and after the warranty program. Customers can choose to uplift the service and support agreement to meet their business needs by purchasing a SunSpectrum contract.

The four levels of SunSpectrum support contracts range from SunSpectrum Bronze℠ level to SunSpectrum Platinum level. Contact a Sun Services representative for further details.

The SunSpectrum contract is for the entire Sun StorEdge 6320 system as a whole (part numbers TA6320-0, XTA6320-00-122-S01, XTA6320-03-122-S01, XTA6320-00-124-S02, XTA6320-03-124-S02, XTA6320-00-122-T02, and XTA6320-03-122-T02). Each base configuration is a product in and of itself.

Each Sun StorEdge 6020 array and expansion cabinet sold in addition to a base cabinet configuration require a separate SunSpectrum contract.

Warranty

The following table indicates warranty details for the Sun StorEdge 6320 system:

Repair Support Duration	Software Support Duration	Phone Coverage		Hardware Coverage		
		Hours of Coverage	Call-Back Response Time	Hours of Coverage	Response Time[30]	Delivery Method
2 years	90 days	24x7	Customer-defined priority	Local, extended business hours	• Same business day • 4 business hours	On-site

For the latest warranty information for the Sun StorEdge 6320 storage system, refer to:

`http://www.sun.com/service/support/warranty/features.html`

Warranty entitlement is for the entire Sun StorEdge 6320 system as a whole (part numbers TA6320-0, XTA6320-00-122-S01, XTA6320-03-122-S01, XTA6320-00-124-S02, XTA6320-03-124-S02, XTA6320-00-122-T02, and XTA6320-03-122-T02). Each base configuration is a self-contained product.

Each additional Sun StorEdge 6020 array and expansion cabinet sold in addition to the base configurations require separate warranty entitlement.

Please note: *Customers may not dismantle or subdivide the Sun StorEdge 6320 system. Any attempt to dismantle or subdivide this system constitutes a modification or alteration of the Sun StorEdge 6320 system, which voids the applicable warranty.*

Contact a Sun Services representative for further warranty details around the Sun StorEdge 6320 system.

SunSpectrum Program Instant Upgrades (Warranty Upgrades)

The following part numbers can be used to upgrade system warranty to the given level of SunSpectrum service for each specified product:

Part Number	Description
W9D-6320-2-2P	6320 base two tray, two 16-port switches, upgrade to 2-year SunSpectrum Platinum program
W9D-6320-2-24-2G	6320 base two tray, two 16-port switches, upgrade to 2-year SunSpectrum Gold program, 24x7
W9D-6320-4-2P	6320 base four tray, two 16-port switches, upgrade to 2-year SunSpectrum Platinum program
W9D-6320-4-24-2G	6320 base four tray, two 16-port switches, upgrade to 2-year SunSpectrum Gold program, 24x7
W9D-6320N2-2P	6320 base two tray, switchless, upgrade to 2-year SunSpectrum Platinum program
W9D-6320N2-24-2G	6320 base two tray, switchless, upgrade to 2-year SunSpectrum Gold program, 24x7

[30] Average response times may vary by country.

Part Number	Description
W9D-6320N4-2P	6320 base four tray, switchless, upgrade to 2-year SunSpectrum Platinum program
W9D-6320N4-24-2G	6320 base four tray, switchless, upgrade to 2-year SunSpectrum Gold program, 24x7
W9D-6320N0-2P	6320 base zero tray, switchless, upgrade to 2-year SunSpectrum Platinum program
W9D-6320N0-24-2G	6320 base zero tray, switchless, upgrade to 2-year SunSpectrum Gold program, 24x7

Sun Educational Services

Sun StorEdge 6320 and 6020 Array Installation and Administration (ES-343)

This course provides students with the knowledge to successfully describe, install, configure, access, maintain, and diagnose the Sun StorEdge 6320 system. Students receive classroom training and hands-on experience with the Sun StorEdge 6320 system.

People who need product specific training on the Sun StorEdge 6320 system should consider taking this course.

At the end of this course, students should be able to do the following:

- Perform system and network administration
- Administer storage with basic storage management software tools
- Describe the features, functions, components, ad architecture of the Sun StorEdge 6320 system
- Install the Sun StorEdge 6320 system hardware
- Install and configure the Sun StorEdge 6320 system's supporting software
- Configure, access, maintain, and diagnose the Sun StorEdge 6320 system

For further information on this course, please visit Sun Educational Services' web site at:

`http://www.sun.com/service/suned`, or to order, please call: 1-800-422-8020

Sun Professional Services

Architecture and Implementation Services

Sun offers a wide variety of consultative services that will help the customer architect their Sun StorEdge 6320 systems into existing storage infrastructures. These services are generally custom-priced engagements that can assist with the design and implementation of larger storage architectures. These services can also assist with analysis of total cost of ownership (TCO), storage migration, comprehensive review of backup and recovery procedures, data replication design and implementation, and security issues.

Backup and Restore Assessment (PS-EO-DSBRV-1)

The Backup and Restore Assessment methodology delivers an assessment of an existing VERITAS NetBackup or Solstice Backup™ environment. The assessment helps ensure that the existing configuration and operational environment meet customer requirements. It reveals weaknesses or shortcomings in the areas of server/client configurations. Additionally, it reviews the historical operations of the backup and restore environment to help ensure the problems are not recurring or unknown. Finally, the service reviews the system management processes and personnel to help ensure operational continuity of the environment.

Tape Library Implementation

The Tape Library Implementation Service delivers a working Sun StorEdge robotic tape library backup system with the hardware and backup and monitoring software components integrated together. This provides customers with a platform that can be used to develop and implement their production backup and recovery policies.

Glossary

Array group	An arrangement of disk drives and the data on them which conform to a RAID level that facilitates organization and the movement of disks between systems. See also Disk group.
Auto-sensing	The ability to automatically determine the type of device connected (N-port, NL-port, F-port, FL-port, or Fabric) and adapt the interface protocol to match.
Block or block size	Also known as stripe unit size, block size is often used to describe the amount of data sent or received by the host per I/O operation. Also used to describe the size of an atomic read/write operation to/from a disk as well as the size of the data unit being "striped" across disks.
Bus	A point-to-point network component.
Cache	Cache is the DRAM based staging area used to provide higher performance to applications for reads and writes. During reads, the RAID controller tries to keep the latest and most often accessed data in the cache and also tries to prestage the cache with future data during sequential accesses. For writes, cache is used to provide delayed writes to the drives. This delays the parity calculations and drive writes during RAID 5 operations. More optimization and advanced staging algorithms thus provide better performance.
Cache hit	A read or write request for data that is already in cache. Therefore, a request can be serviced without needing to go to disk.
Channel	An interface directed toward high-speed transfer of large amounts of information.
Chunk	A quantity of information that is handled as a unit by the host and disk device.
Circuit-switched bus	A bus in which a transaction is normally implemented in an automatic fashion. Simple and easy to construct, a circuit-switched bus is often less efficient than a comparable packet-switched bus. An SBus is a circuit-switched bus.
Clean data	Any read data or write data that has been committed to disk. In other words, a copy of data that is safely on disk.
Concatenation	A volume created by sequentially mapping blocks on disks to a logical device. Two or more partitions can be concatenated and accessed as a single device.
Controller tray	A tray with an installed RAID controller. The standalone controller tray is the smallest possible array configuration. The architecture integrates disks, data cache, hardware RAID, power, cooling, uninterrupted power supply (UPS), diagnostic capabilities, and administration into a versatile, standalone component. The controller unit includes external connections to a data host (or switch), and to a management network.
CRC error checking	Checking for frames that have been corrupted (some of the 1 bits changed to 0 bits, and vice versa), due to noise or collision.
DAS	Direct attach storage. Storage directly attached to servers/hosts (as opposed to SAN storage where storage is attached to a network of storage devices)
Dirty data	Write data that is in cache and has been acknowledged to the application host, but which has not yet been committed to disk.

Disk array	A storage subsystem containing one or more arrangements of multiple disk drives, designed to provide performance, high availability, serviceability, or other benefits. Disk arrays can provide mechanisms to create virtual extents of volumes, such as RAID groups. The physical and logical elements of the array are managed as a group. A disk array can contain multiple trays of disks.
Disk group	An arrangement of disk drives and the data on them which conform to a RAID level that facilitates organization and the movement of disks between systems. See also Array group.
DMP	VERITAS' dynamic multipathing.
Drive depopulation	Drive depopulation allows additional spindles to be added to drive trays that are not fully populated with 14 drives.
Duplexed cache	Cache mirroring with duplicate data paths to and from the cache. See Mirrored cache.
ECC	Error correction code. Extra bits added to Words, or Double Words, that correct all single-bit errors, and detect all double-bit errors. A superior technology to parity, which detects, but does not correct, single-bit errors, and cannot detect double-bit errors.
ELF	Explicit LUN failover.
E_Port	An expansion port connecting two fabric switches.
Event	A change in the state of a managed object.
Expansion tray	A tray without an installed RAID controller (also called expansion unit)
Expansion unit	A tray without an installed RAID controller (also called expansion tray)
Extent	A set of disk blocks with consecutive logical addresses. Extents can be smaller or larger than physical disks. On the Solaris Operating Environment, the format utility can subdivide a disk into several extents called slices (Windows and Linux have a similar concept called partitions). RAID arrays allow users to combine several disks together into a larger "virtual disk." Although the underlying disks are separate extents, the resulting virtual disk is addressed from zero up to its new size; so this virtual disk is also an extent. A volume manager provides a similar capability of merging extents from disks into larger virtual extents.
Fabric	A group of interconnections between ports that includes a fabric element. A collection of switches and the connections between them.
FC-AL	Fibre Channel arbitrated loop, a loop topology used with Fibre Channel.
Fiber	A wire or optical strand. Spelled *fibre* in the context of Fibre Channel.
Fibre Channel	A set of standards for a serial I/O bus capable of transferring data between two ports up to 100 MB/sec. Fibre Channel supports point-to-point, arbitrated loop, and switched topologies. Fibre Channel can be implemented with either optical fiber (note spelling) or copper.
Fiber-optic cable	Jacketed cable made from thin strands of glass, through which pulses of light transmit data. Used for high-speed transmission over medium to long distances.
Floating hot-spare	A drive which remains an active data drive after a RAID controller replaces a failed drive with it. A replacement drive now becomes the new hot-spare drive.

FRU	Field replaceable unit. A component which can be removed and replaced during service in the field.
F_Port	On a Fibre Channel switch, a port that supports an N_port.
GBIC	Gigabit interface converter. A standard form factor which provides a hot-pluggable connection into a Fibre Channel device.
G_Port	On a Fibre Channel switch, a port that supports either F_Port or E_Port functionality.
HBA	Host bus adapter.
Heterogeneous hosts	Application servers running different (disparate) operating systems which are attached to the same storage system.
Hot-pluggable or hot-plug	A hot-pluggable component means that it is electrically safe to remove or add that component while the machine is still running. Sometimes the system must be rebooted before the hot-plug component is configured into the system.
Hot-spare	A drive used by the RAID controller to replace a failed drive. Hot-spares are continuously powered up and spinning, but are not actually part of the array because they contain no data. This allows the array processor to have immediate access to a functioning drive for possible reconstruction of lost data when a disk fails.
Hot-swappable	A hot-swappable component can be installed or removed by simply pulling the component out and putting the new one in. The system either automatically recognizes the component change and configures itself as necessary or requires user interaction to configure the system; however, in neither case is a reboot required. All hot-swappable components are hot-pluggable, but not all hot-pluggable components are hot-swappable.
Hub	A dedicated bandwidth device for connecting fiber devices.
ILF	Implicit LUN failover.
In-band	This is the datapath between the host and storage system, which provides data access/storage. This is typically Fibre Channel or SCSI in block-based storage systems and Ethernet in NAS storage systems.
Initiator	On a Fibre Channel network, typically a server or workstation that initiates transactions to disk or tape targets.
Interleaved memory	Helps reduce memory access time by permitting multiple memory components to operate in parallel. Memory is divided into n banks arranged so that every nth byte is supplied by a different memory bank. In a two-way interleaved system, the first double word is supplied by bank 0 while the second is supplied by bank 1. Normally, the size and extent of interleave is arranged so that a single typical request is satisfied by as many banks as possible. This arrangement permits a single memory request to be fulfilled without waiting for memory recycle time.
I/O	Input/output.
I/O rate	A measure of a devices capacity to transfer data to and from another device within a given time period, typically as I/O operations per second.
IOPS	Input/output operations per second. A measure of I/O performance, this is commonly used to quote random I/O performance.

IP	Internet protocol. A set of protocols developed by the United States Department of Defense to communicate between dissimilar computers across networks.
ITW	Invalid Transmit Word, a statistical counter that tracks 10bit errors on FC links. The most common cause of an ITW is jitter/noise from the downstream transmitter. These errors are detected at the FC receiver as invalid 10bit symbols.
LED	Light emitting diode.
Link	One inbound fiber and one outbound fiber connected to a port.
Longwave GBIC	Gigabit interface converter designed for transmission of data over long (10 km) distances.
LRC	Loop redundancy circuit.
LUN	Logical unit number. A numbering sequence for devices connected to a computer. SNIA uses the term "volume" for this definition.
Mirror	To duplicate data from a primary location to a secondary location, so that the data is still available if the primary location fails.
Mirrored cache	Redundant copies of data residing in cache — the (write) data residing in cache which has not yet been written to the hard disks is duplicated for failover operation.
Mirroring (RAID)	Redundant storage of data, achieved by duplicating files (so there is always a primary file and a copy of the primary file) onto separate disks.
Mirror synchronization	The process by which VERITAS Volume Manager software keeps two or more copies of data identical.
Multipathing	The ability to manage two or more physical or logical paths to a given target or device.
Network	An arrangement of nodes and connecting branches, or a configuration of data processing devices and software connected for information exchange.
Network terminal concentrator (NTC)	A modem connection point for the Sun StorEdge℠ Remote Response service. Helps facilitate a point-to-point connection from a remote support center.
Nondisruptive	Does not prevent system or data access at any time during operation; data path access is not sacrificed; host does not see any I/O failure (unless dual points of failure); may no longer a be an HA environment; availability of management services not included
Non-floating hot-spare	A drive that reverts back to hot-spare status after a failed drive has been replaced and the mirror resilvered or the stripe rebuilt.
N_Port	A Fibre Channel port in a point-to-point or fabric topology.
NL_Port	A port attached to a node for use in all three topologies (point-to-point, arbitrated loop or fabric).
Node	A device that has at least one N_Port or NL_Port.
NTC	Network terminal concentrator — see above.

NVRAM cache	A non-volatile (battery-backed) random access memory area used as an intermediate store for data between a host computer system and disk drives to achieve faster writes and, in some cases, faster reads.
OLTP	On-line transaction processing.
Optical fiber	Any filament of fiber, made of dielectric material, that guides light.
Out-of-band	Transmission of a management protocol outside of the Fibre Channel network, typically over Ethernet.
Packet-switched bus	A bus in which information is transmitted in fixed-sized units. This type of bus is often associated with the use of split transactions. Gigaplane™ and UPA are packet-switched buses.
Parity	In an array environment, data that is generated from user data and is used to regenerate user data lost due to a drive failure. Used in RAID 5. Parity is one form of data path protection used by hardware components to ensure proper transmission of data. A single parity bit is either asserted or deasserted in parallel with the data being sent, dependent upon the balance of ones and zeros in the data. If even parity is employed, a one bit is asserted on the parity line if the number of ones in the data is odd, otherwise it is deasserted.
Parity error handling	Parity error handling refers to the processing of the data when the parity does not match the data sent, signifying an error condition. A single parity bit can only be used to detect a single or odd number of bit errors. error correction codes (ECC) provide a more stable medium with their ability to correct single bit errors and detect multiple bit errors using encoded polynomials. In the context of Fibre Channel switches, they contain counters to collect and report any internal parity errors detected by their hardware.
Sun StorEdge 6020 or HA controller configuration	Two controller units providing redundant data and management paths and mirrored cache duplexing (which provide controller failover and path failover capability).
Path failure	Path failure occurs when I/O to a unit is interrupted for any reason other than for a controller failure — the failure could be in a cable, could be in a host adapter, or could occur because of a non-I/O root cause such as removal of an application host system I/O board. Regardless of the cause of the interruption, I/O requests targeted at a LUN eventually time out. The I/Os are then redirected to the alternate path for that LUN.
Point-to-point	A topology where exactly two ports communicate.
Pool	See Storage pool.
Port	An access point on a device for attaching a link.
Protocol	A convention for data transmission that defines timing, control, format, and data representation.
RAID	Redundant array of independent disks. A set of disk drives which appear to be a single logical disk drive to an application such as a database or file system. Different RAID levels provide different capacity, performance, availability, and cost characteristics.

RAID 0	RAID level 0, or striping without parity or mirroring protection. Data is distributed evenly at the block level among disks for performance. No redundancy is provided, and the loss of a single disk causes the loss of data on all disks. Use this level for high-speed streaming of large file reads (for example, video) of non-critical data which is easily available elsewhere within the organization.
RAID 1 (1+0)	RAID level 1 (1+0), or mirroring with striping. Data is stored at the file level. Files reside on separate disks, and two copies of the data are kept. Each data block in a RAID 1(1+0) volume is mirrored on two drives, and the blocks are striped across all the drives in a storage pool. If one of the mirrored pair fails, the data from the other drive is used.
RAID 5	RAID level 5, or striping with distributed parity. Both data and parity information are striped across the drives. Because of parity, if a single drive fails, data can be recovered from the remaining drives. Two drive failures cause all data to be lost. In other words, both data and parity are distributed evenly across all the disks in the array at the block level. No single disk can compromise the integrity of the data.
RAID 5 (7+1) with standby hot-spare	Sun StorEdge T3 arrays have nine disks. Eight are used for RAID 5, seven data for and one for parity. The ninth disk is used as a standby hot-spare.
RAID group	A set of disks in which part of the physical storage capacity is used to store redundant information about user data stored on the remainder of the storage capacity. The redundant information enables regeneration of user data in the event that one of the array's member disks or the access path to it fails.
RAS	Reliability, availability, and serviceability. Reliability is a measure of the likelihood that problems will occur. A highly reliable system has few problems. Once a problem occurs, availability is the measure of how the system protects the user from being adversely affected by the problem. Serviceability is a measure of how easy it is to repair the problem.
Read-ahead	Sequential data read from disk into cache without having actually been requested by the application host, in anticipation that it will be requested by the host. When the request occurs, it can be serviced as a low latency cache hit, thus improving host application performance.
Receiver	The circuitry that receives signals on a fiber, and the ultimate destination of data transmission.
Reconstruction	The process of rebuilding lost data on a replacement drive after a drive failure.
Redundancy	Duplication for the purpose of achieving fault tolerance. Refers to duplication or addition of components, data and functions within the array.
SAN	Storage area network. SAN architecture uses high-performance, high-capacity Fibre Channel switches to connect storage islands to servers. This approach provides physical connectivity, facilitating information sharing or simplifying management across servers.
SCSI	Small computer systems interface. An ANSI standard for controlling peripheral devices by one or more host computers.
Segment	An over-used term; in the context of the Sun StorEdge 6020 array, 1/8 of a cache buffer. A segment is the smallest size of I/O possible between cache and disk.

Serial transmission	Data communication mode where bits are sent in sequence in a single fiber.
Shortwave GBIC	Gigabit interface converter designed for transmission over a maximum distance of 500 meters.
SFP	Small form pluggable. See GBIC.
Single-mode fiber	A step index fiber wave guide in which only one mode (ray of light) propagates above the cutoff wavelength.
SNMP	Simple network management protocol. A simple protocol designed to allow networked entities (for example, hosts, routers) to exchange monitoring information.
SSP	Storage Service Processor.
Storage array	A storage system containing multiple disk drives, designed to provide performance, high availability, serviceability, or other benefits. Disk arrays can provide mechanisms to create virtual extents of volumes, such as RAID groups. The physical and logical elements of the storage array are managed as a group. A storage array must contain at least one tray with a RAID controller.
Storage extent	See "Extent."
Storage pool	A collection of storage extents with the same Quality of Service. The service level could be very precise (must be RAID protected with at least one hot-spare) or vague (any disk storage, with or without redundancy). There can be multiple pools with the same service level. (also called RAID group)
Stripe size	Total amount of data in a disk stripe; that is, the block size multiplied by number of data disks in the stripe.
Stripe width	Total number of disks in a disk stripe.
Striping	Spreading or interleaving logical contiguous blocks of data across multiple independent disk spindles. Striping allows multiple disk controllers to simultaneously access data, improving performance.
Switch	The name of an implementation of the fabric topology. A fabric element that implements a fabric. The fabric element that allows each port of a switch to be connected to any other port on that switch. A collection of switches implement a fabric and provide the network through which any device can communicate with any other device.
Switched-loop architecture	Splits the drive interface into multiple, independent loops so that the RAID controller has its own drive loop, plus access to other drive loops. Improves performance and expansion flexibility for enterprise networks.
Syslog	The internal log file maintained by Sun StorEdge 6020 arrays to track events and alerts as well as informational and notice messages. This log file can be sent periodically to a host server for evaluation using the `syslogd(1M)` function.
Target	A disk array on a Fibre Channel network.
Telemetry Stream	Stream of data generated by monitoring agents.
Throughput	A measure of sequential I/O performance, quoted as megabytes per second (MB/sec.). See IOPS and I/O rate.

Topology	The components used to connect two or more ports together. Also, a specific way of connecting those components, as in point-to-point, fabric, or arbitrated loop.
Transfer rate	The rate at which data is transferred, usually measured in megabytes per second (MB/sec.).
Tray	Refers to a single Sun StorEdge 6020 array enclosure. If one is referring to multiple "trays" connected together, that new entity would be referred to a storage array (see definition above).
Volume	A volume is a virtual disk into which a file system, a DBMS, or an application can place data. A volume can be a single physical disk or a virtual disk mapped from one or more underlying extents. Applications that use volumes do not need to be aware of their underlying physical structure. Software handles the mapping of virtual partition addresses to physical addresses.
Volume masking	Assigning volume permissions (read-only, read/write, or none) to a host.
Warm boot device	Bootable on all supported HBAs with storage booted before server booting.
Write-behind mode	A data write is acknowledged to the application host as soon as it is in cache, without having yet been committed to disk, in order to reduce write latency. Also known as write-back or fast-write mode.
Write-through mode	A data write is acknowledged only after data has been fully committed to disk.
WWN	World Wide Name.
Zone or zoning	Provided by fabric switches, a function that allows segmentation of node by physical port, name, or address.

Materials Abstract

Unless otherwise noted, all materials are available on SunWIN.

Collateral	Description	Target Audience	Distribution	Token # or COMAC Order #
Just The Facts				
– *Sun StorEdge™ 6320 Series Storage Systems, Just the Facts*	Reference Guide (this document)	Sales Tool	SunWIN, Reseller Web	367061
– *Sun StorEdge Network FC Switch-8 and Switch-16, Just the Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	128888
– *Sun StorEdge SAN 4.X release, Just the Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	345251
– *Sun StorEdge Enterprise Storage Manager (ESM) Software, Just The Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	352908
– *Sun StorEdge Availability Suite 3.1 Just The Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	327180
– *Sun StorEdge Utilization Suite and Performance Suite Just The Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	304737
– *VERITAS Volume Manager Just The Facts*	Reference Guide	Sun SE	SunWIN, Reseller Web	67745
Customer Presentations				
– *Sun StorEdge 6320 System & Sun StorEdge 6120 Array Customer Presentation*	Presentation	Sales Tool	SunWIN, Reseller Web	367054
– *Sun StorEdge Availability Suite 3.1 Customer Presentation*	Presentation	Sales Tool	SunWIN, Reseller Web	317927
– *Sun StorEdge Utilization Suite and Performance Suite NDA*	Presentation	Sales Tool	SunWIN, Reseller Web	354784
– *Sun StorEdge Unified 2 GB SAN Infrastructure Customer Presentation*	Presentation	Sales Tool	SunWIN, Reseller Web	345252
– *VERITAS Volume Manager Customer Presentation*	Presentation	Sales Tool	SunWIN, Reseller Web	134067 115226
Technical Presentations				
– *Sun StorEdge 6320 System Technical Presentation*	Technical Presentation	Sales Tool	SunWIN, Reseller Web	374939
Competitive Notes				
– *Sun StorEdge 6320 System Beat Sheet*	Competitive Comparison	Sales Tool	SunWIN, Reseller Web	374948

Collateral	Description	Target Audience	Distribution	Token # or COMAC Order #
References				
– *Sun StorEdge 6120 Array and Sun StorEdge 6320 System Data Sheet*	Data Sheet	Sales Tool	SunWIN, Reseller Web, COMAC	367052, DE1813-0
– *Sun StorEdge 6320 System Pocket Facts*	Fast Facts	Sales Tool	SunWIN, Reseller Web	367059
– *Sun StorEdge 6120 Array and Sun StorEdge 6320 System Elevator Pitch*	Elevator Pitch	Sales Tool	SunWIN, Reseller Web	374938
– *Sun StorEdge Availability Suite Data Sheet*	Data Sheet	Sales Tool	SunWIN, Reseller Web, COMAC	317926, DE1561-1
– *Sun StorEdge HBA Product Brief*	Sales Guide	Sales Tool	SunWIN, Reseller Web	345257
– *SAN 4.X WWWW Matrix*	Configuration Matrix	Sales Tool	SunWIN, Reseller Web	347688
White Papers				
– *Sun StorEdge Remote Response Security White Paper*	Technical Brief	Training	SunWIN, Reseller Web	372755
– *Sun StorEdge Availability Suite 3.0 and 3.1 Software — Using Remote Mirror Software in Asynchronous Replication Mode*	Technical Brief	Sales Tool	SunWIN, Reseller Web	368350
– *Sun StorEdge Availability Suite Software Improving Data Replication Over a Highly Latent Network*	Technical Brief	Sales Tool	SunWIN, Reseller Web	356832
– *Sun StorEdge Availability Suite Software Performance Improvement White Paper*	Technical Brief	Sales Tool	SunWIN, Reseller Web	356830
– *Sun StorEdge Availability Suite Software — Compared With ORACLE Replication*	Technical Brief	Sales Tool	SunWIN, Reseller Web	351157
– *Sun StorEdge Availability Suite Software — Maximizing Read-Only Volume Access*	Technical Brief	Training	SunWIN, Reseller Web	351155
– *Point-in-Time Copy Software — Maximizing Backup Performance*	Technical Brief	Training	SunWIN, Reseller Web	351159
– *Fibre Channel Technology from Sun Microsystems*	Technical Brief	Training	SunWIN, Reseller Web	65659

Collateral	Description	Target Audience	Distribution	Token # or COMAC Order #
– *Fibre Channel versus Alternative Storage Interfaces: An Overview*	Technical Brief	Training	SunWIN, Reseller Web	65663
– *The Sun Storage Value Proposition for High Performance Computing White Paper, 01-01-02*	Technical Brief	Training	SunWIN, Reseller Web	334572
– *Business Continuity Goes Better with SANs — The 3 Rs of Resilience White Paper, 02-06-02*	Technical Brief	Training	SunWIN, Reseller Web	332518
External Web Sites				
– *Sun StorEdge 6320 System Main Page*	`http://www.sun.com/storage/enterprise/6300`			
– *Sun StorEdge 6020 Array Main Page*	`http://www.sun.com/storage/6100`			
– *Fibre Channel Association*	`http://www.fibrechannel.com`			
– *Sun StorEdge Availability Suite*	`http://www.sun.com/storage/software/availability/`			
– *Fibre Channel Loop Community*	`http://www.fcloop.org`			
– *Sun StorEdge 6320 System Multiplatform Support*	`http://www.sun.com/storage/san/multiplatform_support.html`			
– *VERITAS Volume Manager*	`http://www.sun.com/storage/software/storage_mgmt/volumemgr/index.html`			
Internal Web Sites				
– *Storage Products Internal Site for the Sun StorEdge 6000 Family*	`http://webhome.sfbay/networkstorage/products/6000`			
– *Storage Products Internal Site for the Sun StorEdge 6300 Series*	`http://webhome.sfbay/networkstorage/products/6300`			
– *Storage Products Internal Site for the Sun StorEdge 6320 System*	`http://webhome.sfbay/networkstorage/products/6320`			
– *Storage Products Internal Site for the Sun StorEdge 6100 Series*	`http://webhome.sfbay/networkstorage/products/6100`			
– *Storage Products Internal Site for the Sun StorEdge 6020 Modular High Availability Storage Array*	`http://webhome.sfbay/networkstorage/products/6020`			
– *Sun StorEdge Remote Response Service*	`http://ssge.central/rs/ichabod/`			
– *Sun StorEdge Availability Suite Software Site*	`http://webhome.ebay/networkstorage/products/software/availability/`			
– *Switch Information*	`http://webhome.ebay/products/switch/index.html`			
– *VERITAS Volume Manager*	`http://webhome.ebay/networkstorage/products/volumemgr/`			
– *Configuration Rules Page*	`http://webhome.ebay/networkstorage/performance/confrules`			

Collateral	Description	Target Audience	Distribution	Token # or COMAC Order #

– *WWWW Matrix Web Page*
– *Storage Products Internal Site for Sun StorEdge Utilization Suite and Sun StorEdge Performance Suite*
– *Resources Web Site*
	`http://webhome.ebay/products/sales/matrix.html`
	`http://webhome.sfbay/datapath/sam-qfs`
	`http://webhome.ebay/networkstorage/contacts/`			

– *Network Storage Sales Center (Help Desk)* – *SunSpectrum℠ Program Information*	`http://webhome.sfbay/networkstorage/sales` `http://service.central/TS/ESP/SunSpectrum/Feature_Matrix/index.html`			

FAQs

Sun StorEdge™ 6320 systems Frequently Asked Questions are not included in this document since they are frequently updated. They are found at the following website:

There are now two separate FAQ documents, as follows:

- Internal use only = Sun StorEdge 6320 system INTERNAL FAQs, `http://webhome.ebay/networkstorage/products/` under Sun StorEdge 6320
- External use = Sun StorEdge 6320 system EXTERNAL FAQs, found on `http://www.sun.com/storage/`

Competitive Comparisons

Principal competition for the Sun StorEdge™ 6320 system includes the EMC CLARiiON CX600, HDS Thunder 9500, HP StorageWorks EVA, and IBM FAStT900.

Feature	EMC CLARiiON CX600	HDS Thunder 9570	HP StorageWorks EVA	IBM FAStT900	Sun StorEdge 6320 System
Maximum Raw Capacity	35 TB	30 TB	35 TB	32.8 TB	45T B
Maximum Drive Count	240	210	240	220	308
Maximum Cache (mirrored)	8 GB	4 GB	8 GB	2 GB	22 GB
Maximum Volumes (LUNs)	1024	512	8092	64 (2,048 with optional software)	704
Maximum Host Connectivity	• 8 ports • 128 hosts	• 4 ports • 512 hosts	• 4 ports • 256 hosts	• 8 ports • 64 hosts	• 22 ports(11HA) • 176 hosts
RAID Levels	0, 1, 3, 5, 1+0	0, 1, 5, 1+0	0, 1, 5	0, 1, 3,5, 1+0	0, 1(1+0), 5
Host Support	Solaris, HP-UX, AIX, Linux, NetWare, Tru64, IRIX, WinNT	Solaris, HP-UX, AIX, Linux, NetWare, Tru64, IRIX, WinNT, Win2000, NCR, Dynix, TRIX	Solaris, HP-UX, AIX, Linux, NetWare, Tru64, OpenVMS, WinNT	Solaris, HP-UX, AIX, Linux, NetWare, WinNT	Solaris, HP-UX, AIX, Linux, WinNT, Win2000
HA Cluster Support	VERITAS Cluster Solaris, MS Cluster NT/200, HP-UX, IBM HACMP, TruCluster	VERITAS Cluster Solaris, MS Cluster NT/2000, HP-UX, IBM HACMP, SGI-IRIX, Novell Cluster, TruCluster	VERITAS Cluster Solaris, MS Cluster NT/2000, HP-UX, IBM HACMP, TruCluster	MS Cluster NT/2K, Novell Cluster, Linux GPFS, (VERITAS Cluster Solaris, IBM HACMP, HP Service Guard)* (scheduled for June 2003)	Sun Cluster 3.X
Path Fail-Over Support	PowerPath — WinNT Solaris, AIX +	Dynamic Link — WinNT Solaris, HP-UX, AIX +	Secure Path — WinNT, Solaris, HP-UX, AIX	SANtricity — WinNT, Solaris, HP-UX, AIX	Traffic Manager — Solaris
Warranty Period	2 years	3 years	3 years	3 years	2 years
Support — Phone Coverage	24x7	24x7	24x7	24x7	24x7

Feature	EMC CLARiiON CX600	HDS Thunder 9570	HP StorageWorks EVA	IBM FAStT900	Sun StorEdge 6320 System
Support — On-Site Coverage	24x7	None	24x7	5x9 (next business day	Extended business hours (8 a.m. to 8 p.m.) Monday-Friday
Support — On-Site Coverage Response Time	4 hours	N/A	4 hours	Next business day (excludes holidays)	4 hours