Ultra™ Enterprise™

3000–6000

Just the Facts

Part 1 of 2

Copyrights

Positioning

Product Overview

Sun's Ultra™ Enterprise™ server family is ideally suited for mission-critical network computing environments. Family members range from the entry-level Enterprise 1 desktop server to the mainframe-class Enterprise 10000 server. This document focuses on the Enterprise 3000–6000 servers.

Key Messages

The Enterprise servers offer excellent performance, reliability, availability, and serviceability (RAS), along with expandability, investment protection, and upgradability.*

- **Performance.** The Enterprise 3000–6000 servers share a common architecture that is designed to offer balanced system performance. The systems feature outstanding integer and floating-point performance supporting up to thirty UltraSPARC™ modules in the Enterprise 6000. The system bus (Gigaplane™ bus) runs at 2.5 GB/sec. High-speed networking is supported with integrated 10/100-Mb Ethernet and optional FDDI, ISDN, Token Ring, and ATM interfaces. Fast I/O capability is supported through either 64-bit SBus and on-board fast/wide SCSI and Fibre Channel interfaces or 64-bit PCI and on-board fast/wide SCSI interface. The following table shows a performance comparison of the SPARCserver™ 1000E, the Enterprise 3000, and the Enterprise 4000 servers.

Table 1:

Performance Type	SPARCserver 1000E	Enterprise 3000	Improvement over SPARCserver 1000E	Enterprise 4000	Improvement over SPARCserver 1000E
Relative CPU performance - integer - floating point	 1 (8) 1 (8)	 ~3 (6) ~3.8 (6)	 ~3x ~3.8x	 ~5.5 (14) ~8.9 (14)	 ~5.5x ~8.9x
Sustained system bus throughput	312 MB/sec.	2.5 GB/sec.	8x	2.5 GB/sec.	8x
Memory latency	1200 ns	~300 ns	4x	~300 ns	4x
Networking performance	10 Mb/sec.	100 Mb/sec.	10x	100 Mb/sec.	10x
I/O performance	1 to 4 SBuses 100 MB/sec.	1 to 6 SBuses 200 MB/sec. each 1 to 6 PCI buses 528 MB/sec. each	≥ 3x	1 to 14 SBuses 200 MB/sec. each 1 to 12 PCI buses 528 MB/sec. each	≥ 7x
SCSI performance	10 MB/sec.	20 MB/sec.	2x	20 MB/sec.	2x

* Performance excellence can be substantiated by comparing E6000 SPECint-rate95, SPECfp_rate95, and TPC-C results from competitive systems from HP, IBM, and DEC.

Key Messages *(cont.)*

The following table shows a performance comparison of the SPARCcenter™ 2000E and the Enterprise 6000 server:

Table 2:

Performance Type	SPARCcenter 2000E	Enterprise 6000	Improvement over SPARCcenter 2000E
Relative CPU performance - integer - floating point	 1 1	 ~4.2 (30) ~6.5 (30)	 ~4.2x ~6.5x
Sustained system bus throughput	625 MB/sec.	2.5 GB/sec.	4x
Memory latency	1200 ns	~300 ns	4x
Networking performance	10 Mb/sec.	100 Mb/sec.	10x
I/O performance	1 to 10 SBuses 100 MB/sec.	1 to 30 SBuses 200 MB/sec. each 1 to 12 PCI buses 528 MB/sec. each	≥ 6x
SCSI performance	10 MB/sec.	20 MB/sec.	2x

- **Reliability, Availability, and Serviceability (RAS)**. Extensive RAS capabilities are one of the key strengths of the Enterprise 3000–6000 servers. The table below shows the RAS features that are built into the servers. For more details on these features, see “Reliability, Availability, and Serviceability” later in this section of this document.

Table 3:

Reliability Features	Availability Features	Serviceability Features
– *Passive centerplane bus* – *ECC-protected data* – *Parity-protected address and control signals* – *Current-sharing power circuitry* – *Fewer active components than previous generation*	– *Redundant UltraSPARC modules* – *Redundant CPU/memory boards* – *Redundant I/O boards* – *Redundant power supplies* – *Enhanced Automatic System Recovery (ASR)* – *Dual, variable-speed fans in each cooling unit* – *Dual disk array host interfaces*	– *Modular system design* – *Hot-plug CPU/memory boards* – *Remote booting and power cycling* – *Hot-swap disk drives* – *Hot-swap power/cooling modules* – *Sun™ Validation Test Suite (SunVTS™)*

- **Expandability.** Enterprise 3000–6000 servers can be expanded from small, entry-level configurations to system configurations that handle terabytes of data and thousands of users.

Key Messages *(cont.)*

- **Scalability.** Enterprise 3000–6000 servers are designed as highly modular systems. Customers can easily configure these systems to meet their application requirements by using the appropriate mix of CPU/memory boards and I/O boards. In addition, as their computing or I/O performance needs increase, customers can easily add capability to these systems by simply adding UltraSPARC modules, SIMMs, or I/O boards. A high-throughput system bus and I/O architecture eliminate system bottlenecks and ensure balanced system performance, even in a system with the maximum number of UltraSPARC modules or I/O devices.
- **Investment Protection.** Virtually all of the components used in the Enterprise 3000–6000 servers are interchangeable. These components include CPU/memory boards, I/O boards, disk boards, UltraSPARC modules, SIMMs, power/cooling modules, clock boards, and peripherals. Therefore, when upgrading to a larger system (for example, from an Enterprise 4000 to an Enterprise 6000 server), customers can move these components from the existing system to the new system, protecting their investment.
- **Upgradability.** The modular design of the Enterprise 3000–6000 servers means that upgrading to new technologies and higher performance is easy. These systems is designed to support future generations of UltraSPARC processors, disk arrays, tape devices, and networking interface cards.

Enterprise 3000–6000 Key Facts

- Enterprise 3000 supports one to six 167-, 250-, or 336-MHz UltraSPARC modules.
- Enterprise 4000 and 5000 support one to fourteen 167-, 250-, or 336-MHz UltraSPARC modules.
- Enterprise 6000 supports one to thirty 167-, 250-, or 336-MHz UltraSPARC modules.
- Gigaplane system bus delivers a sustained throughput rate of 2.5 GB/sec. and a peak rate of 2.6 GB/sec.
- Up to four boards can be installed in the Enterprise 3000.
- Up to eight boards can be installed in the Enterprise 4000 or 5000.
- Up to sixteen boards can be installed in the Enterprise 6000.
- Five types of plug-in boards are available:
  - CPU/memory board
  - SBus I/O board
  - Graphics I/O board
  - PCI I/O board
  - Disk board (Enterprise 4000, 5000, and 6000 only)

Enterprise 3000–6000 Key Facts *(cont.)*

- CPU/memory boards can support up to two UltraSPARC modules and up to 2 GB of RAM.
  - Two banks of eight SIMM slots each, supporting in total up to 16 SIMMs
- SBus I/O board with FC-AL (2611A) has three SBus slots, two empty FC-AL sockets , one fast/wide SCSI port and one 10/100-Mb/sec. Ethernet port. This board has two SBus channels.
- SBus I/O board with Fibre Channel (2610A) has three SBus slots, two Fibre Channel connectors (optical link modules not included), one fast/wide SCSI port and one 10/100-Mb/sec. Ethernet port. This board has two SBus channels.
- Graphics I/O boards contain two SBus slots, one UPA slot for a Creator or Creator3D graphics board, two Fibre Channel connectors (optical link modules not included), one fast/wide SCSI port, and one 10/100-Mb Ethernet port. This board has one SBus channel.
- PCI I/O boards have two PCI slots, on-board fast/wide SCSI and 10/100-Mb/sec. Ethernet. This board has two PCI-66 (66 MHz, 64-bit) channels and two standard PCI (33 MHz, 32-bit) channels.
- The 4.2-GB disk board contains two 2.1-GB, 7200-rpm, fast/wide SCSI-2 disk drives.
- Enterprise 3000–6000 servers support redundant, hot-swappable power/cooling modules (PCMs).
- CPU/memory boards are hot-pluggable. Hot-swap software support will be phased in over time.
- Virtually all components are interchangeable among the Enterprise 3000–6000 servers.
- Requires the Solaris™ 2.5.1 (or later) operating environment.
- Memory options include 256 MB (8 x 32-MB SIMMs) and 1 GB (8 x 128-MB SIMMs).
- Enterprise 3000 floor brackets may be installed to help prevent the Enterprise 3000 from shifting in case of extreme floor movement.
- Enterprise cabinet floor brackets may be installed to help prevent the Enterprise 5000, 6000, and Expansion cabinet from shifting in the event of extreme floor movement.
- Enterprise 4000 may be rack-mounted into an Enterprise expansion cabinet or Enterprise 5000 system cabinet.
- StorEdge A5000's, SPARCstorage™ Array Model 100 Series, SPARCstorage™ RSM™ trays, differential SCSI disk trays, multi-tape backup trays, and SPARCstorage™ Libraries may be configured into the Enterprise 5000 or 6000 system cabinet.

Performance Comparison

. (Results based on 336-MHz, 4-MB E-cache modules.)

Table 4:

Specifications	Enterprise 3000 (6 CPUs)	Enterprise 4000 (12 CPUs)	Enterprise 5000 (12 CPUs)	Enterprise 6000 (30 CPUs)
Estimated tpm	17,800	29,300	29,300	40,500 (24 CPUs)
SPECint_rate95	767	1,487	1,487	3,480 (30 CPUs)
SPECfp_rate95	1036	1,798	1,798	3,021 (30 CPUs)
LADDIS	11,681@15.8	21,192@15.7	21,192@15.7	27,954@17.5 (18 CPUs)
Linpack DP 1000	1.99	3.72 (14 CPUs)	3.72 (14 CPUs)	5.19 (30 CPUs)
Linpack DP Rmax	3.67	8.53 (14 CPUs)	8.53 (14 CPUs)	17.89 (30 CPUs)

The next few pages describe how Sun has positioned each member of the Enterprise family. This information will help in determining which Enterprise system best fits the customer's current and future computing needs, as well as the overall technology strategy of this product family.

Product Line Summary

The Enterprise family of servers is targeted at strategic markets chosen by Sun: manufacturing, finance, telecommunications, government, education, health care, retail, design automation, and oil and gas. The following describes how each server in the Enterprise family has different characteristics and is therefore deployed in a different fashion within the target markets.

Target Markets and Users for the Enterprise 10000

The Enterprise 10000 is targeted for high-end commercial and technical markets. Key applications include data warehousing, data mining, high-volume OLTP, LAN consolidation, analystics, and Internet/intranet.

The Enterprise 10000 should be recommended when

- The customer's simultaneous processing and I/O requirements cannot be met with one Enterprise 6000
- Customer's availability requirements cannot be met by one Enterprise 6000
- There is no reason to prefer two clustered Enterprise 6000s over one Enterprise 10000 (where failover is not required)
- System administration prefers one large centralized system (potentially split into domains) over multiple, smaller ones

See *Ultra Enterprise 10000 Just the Facts* for more detailed information on this product.

Product Line Summary *(cont.)*

Target Markets and Users for the Enterprise 6000

The Enterprise 6000 is ideal for customers who need to build network computing applications of a size and scale that previously required mainframes. The customer receives the benefits of improved data access and flexibility even as databases grow to multiple terabytes. Typical Enterprise 6000 customers may already own large SPARCcenter 2000 systems.

The Enterprise 6000 offers more than two times the CPU and memory expandability of the Enterprise 5000. The Enterprise 6000 should be recommended when the Enterprise 5000 does not offer enough expandability and the Enterprise 10000 offers too much head room.

The Enterprise 6000 should be recommended over the Enterprise 10000 when

- The customer's simultaneous processing and I/O requirements can be met with one Enterprise 6000
- The Enterprise 6000 meets the customer's availability requirements
- Customer is driven to clustering for seamless failover requirements
- Customer prefers to distribute many smaller systems rather than take a centralized approach with one large system

Target Markets and Users for the Enterprise 5000

The Enterprise 5000 is a scalable and reliable datacenter server for mission-critical applications.

The Enterprise 5000 is ideal for customers who have mainframe-class system requirements. With features previously available only in proprietary fault-tolerant and mainframe systems, the Enterprise 5000 has the industry's most comprehensive set of uptime features. Typical Enterprise 5000 customers may already own six- to eight-CPU SPARCserver 1000E systems in a stacker unit or data center cabinet. Typical Enterprise 5000 customers may also have two- to six-CPU SPARCcenter 2000E systems.

The Enterprise 5000 is recommended for running mission-critical applications for thousands of users.

The Enterprise 6000 should be recommended when the Enterprise 5000 does not offer enough CPU and I/O growth for the customer.

Product Line Summary *(cont.)*

Target Markets and Users for the Enterprise 4000

The Enterprise 4000 is a versatile server with exceptional value and scalability for companies wanting an easily affordable business server with tremendous computing power, plus the ability to scale system performance and capacity as their needs grow.

The Enterprise 4000 is ideal for customers who need an enterprise-wide application server with high reliability, availability, and serviceability. Typical Enterprise 4000 customers may already own a six- to eight-CPU SPARCserver 1000E.

The Enterprise 4000 is recommended for running business-critical applications that support up to thousands of users. These applications include large departmental databases, customer-management applications, or decision-support applications.

The next-higher model, the Enterprise 5000, should be recommended if the customer needs a rack-mount system with integrated mass storage. The Enterprise 5000 should also be recommended if the customer needs more than two SPARCstorage Array subsystems.

Target Markets and Users for the Enterprise 3000

The Enterprise 3000 is an affordable server with unprecedented power and reliability, enabling customers to deploy sophisticated business and technical applications with the kind of performance and reliability previously available only in very expensive, large-scale systems.

The Enterprise 3000 is ideal for customers who need application servers with tremendous network throughput and processing power, in addition to high reliability, availability, and serviceability. The Enterprise 3000 is also ideal for price-sensitive customers who need integrated storage or want the investment protection offered by an expandable family of servers. Typical Enterprise 3000 customers may already own a SPARCserver 20 or an entry-level SPARCserver 1000E.

The Enterprise 3000 is recommended for running the new generation of network-based business programs, such as SAP R/3, ORACLE Financials, or PeopleSoft Human Resources. The Enterprise 3000 is also recommended for use in technical environments. In those environments, the Enterprise 3000 can be used for running dedicated, computation-intensive applications and high-end graphics applications, such as ECAD and MCAD.

Because the Enterprise 3000 is designed to be a single-enclosure system, the Enterprise 4000 should be recommended when the internal disk storage capacity of the Enterprise 3000 is insufficient. The Enterprise 3000 does, however, support external peripherals. The Enterprise 4000 should also be recommended when the customer's I/O and CPU growth requirements go beyond what the Enterprise 3000 can accommodate.

Product Line Summary *(cont.)*

Product	Positioning	Applications	Markets
Enterprise PDB™	Highest database-availability server configuration for high-volume DSS and OLTP applications.	• Database server	• Manufacturing • Finance • Telecommunications
Enterprise HA	Highly-available server configuration offering fully automated fault-detection and recovery from any single point of failure.	• Database server • NFS™ server	
Enterprise 10000	Highest-end server for customers who require the highest performance and availability. For main-frame-class, mission-critical applications.	• Data warehousing • Data mining • High-volume OLTP • LAN consolidation • Analytics • Internet/intranet	• Financial services • Telecommunications • Government • Petroleum • Education
Enterprise 6000	Highly scalable and expandable, offering performance and availability required for large-scale database applications.	• Data warehousing • Data mining • Business apps • CMS™ OLTP • NFS • Design automation • Analysis and simulation • Video	• Manufacturing • Finance • Telecommunications • Government • Education • Healthcare • Retail • Oil and gas • Pharmaceuticals • Chemical • Internet commerce
Enterprise 5000	Affordable datacenter system designed to deliver high performance and high availability for enterprise-wide applications supporting thousands of users.		
Enterprise 4000	Highly expandable yet compact system delivering high-performance scalability for department applications in a distributed network-computing environment.		
Enterprise 3000	An affordable system for departmental business applications supporting up to hundreds of users in office environments. For customers that want the investment protection of an upgrade path in an expandable family of servers.	• Database server • Business apps • NFS • CMS • Graphics/imaging • Modeling, simulation analysis • Video	• Manufacturing • Finance • Telecommunications • Government • Education • Healthcare • Retail • Oil and gas • ECAD/MCAD • Internet commerce

Product Line Summary *(cont.)*

The following chart illustrates the specifications of the Enterprise Server product line.

Table 5:

Specifications	Enterprise 3000	Enterprise 4000	Enterprise 5000	Enterprise 6000	Enterprise 10000
Packaging	Tower	Tabletop/ deskside	Rack	Datacenter rack	Datacenter rack
Number of CPUs	1 to 6	1 to 14	1 to 14	1 to 30	16 to 64
CPU clock rate	167, 250, 336MHz	167, 250,336MHz	167, 250,336MHz	167, 250, 336 MHz	250, 333 MHz
Ecache per CPU	4 MB (336/250 MHz only) or 1 MB (167/250 MHz only)	4 MB (336/250 MHz only) or 1 MB (167/250 MHz only)	4 MB (336/250 MHz only) or 1 MB (167/250 MHz only)	4 MB (336/250 MHz only) or 1 MB (167/250 MHz only)	4 MB or 1 MB (250 MHz only)
Maximum Memory	6 GB	14 GB	14 GB	30 GB	64 GB
Peak System Bus	2.6 GB/sec.	2.6 GB/sec.	2.6 GB/sec.	2.6 GB/sec.	10.5 GB/sec.
Sustained System Bus	2.5 GB/sec.	2.5 GB/sec.	2.5 GB/sec.	2.5 GB/sec.	10.4 GB/sec.
Maximum SBus/PCI slots	9 / 6	21 / 12	21 / 12	45 / 12	64
Maximum Internal Disk	91 GB	16.8 GB	216 GB	162 GB	189 GB
Max Total Disk	> 2 TB	> 4 TB	> 6 TB	> 10 TB	> 20 TB
RAS Features	Hot-swap disks RAID 0, 1, 5 Hot-disk sparing Hot-plug boards Hot-swap power Hot-swap cooling Redundant power ASR Solstice™ SyMON™ Remote control ECC-protected data paths ECC memory CPU Power Control (Solaris 2.6)	Hot-plug boards Hot-swap power Hot-swap cooling Redundant power ASR Solstice SyMON Remote control ECC-protected data paths ECC memory CPU Power Control (Solaris 2.6)	Hot-plug boards Hot-swap power Hot-swap cooling Redundant power ASR Solstice SyMON Remote control ECC-protected data paths ECC memory CPU Power Control (Solaris 2.6)	Hot-plug boards Hot-swap power Hot-swap cooling Redundant power ASR Solstice SyMON Remote control ECC-protected data paths ECC memory CPU Power Control (Solaris 2.6)	Hot-swap boards Fault-tolerant power ASR Hostview Remote control ECC-protected data paths ECC memory Dynamic domains

Product Line Summary *(cont.)*

Enterprise Server product line (cont.).

Specifications	Enterprise 3000	Enterprise 4000	Enterprise 5000	Enterprise 6000	Enterprise 10000
Operating System	Solaris 2.5.1 or Solaris 2.6	Solaris 2.5.1 or Solaris 2.6	Solaris 2.5.1 or Solaris 2.6	Solaris 2.5.1 or Solaris 2.6	Solaris 2.5.1 or Solaris 2.6
Warranty	1 year next-day on-site 8-hour phone	1 year next-day on-site 8-hour phone	1 year 4 hours on-site 4-hour phone	1 year 4 hours on-site 4-hour phone	1 year 4 hours on-site 4-hour phone

Reliability, Availability, and Serviceability

The Ultra Enterprise 3000–6000 servers offer excellent reliability, availability, and serviceability (RAS) features. They are the highest fault-resistant systems in their class. The following is a list of the RAS features found in the Enterprise 3000–6000 servers.

Reliability

- Passive, centerplane bus (Enterprise 4000–6000), or backplane bus (Enterprise 3000), increases mean time between failures (MTBF) of the system.
- Simple, elegant, centerplane bus design reduces the amount of bus circuitry required, increasing the MTBF of the system.
- Current-sharing power circuitry supports redundant power capability.
- ECC-protected data throughout the system increases data integrity.
- Parity-protected address and control signals increase the integrity of these signals.
- Fewer active components than previous-generation servers increases the MTBF.

Availability

- Improved system diagnostics minimize downtime.
- Multiple UltraSPARC modules provide redundancy.
- Enhanced Automatic System Recovery (ASR) quickly reconfigures the system around any failed components.
- Dual variable-speed fans in each power/cooling module keep the system cool if one fan within a module fails.
- CPU Power Control (Solaris 2.6) removes an active CPU from system configuration and powers it off if environmental sensors sense the system is running too hot due to a cooling problem. This is done without any interruption to running processes and without a reboot of the server.
- Remote administration control allows remote reboots and power-cycling.
- Redundant power supplies and current-sharing power circuitry keep the system running if a power supply fails.
- Solstice SyMON, which is included with the Enterprise 3000–6000 servers, maximizes uptime by predicting hardware failures.
- Redundant, time-of-day clock.

Reliability, Availability, and Serviceability *(cont.)*

Serviceability

- Modular system design makes it easy to replace failed components.
- Hot-plug CPU/memory boards make it easy to replace failed boards or to increase the performance of the system.
- Hot-plug I/O boards make it easy to replace failed boards or to increase the I/O capability of the system.
- Hot-swap power/cooling modules make it easy to replace failed modules or to upgrade the power and cooling capacity of the system.
- Solstice SyMON's ability to notify a system administrator of a failure allows the system administrator to know immediately which components have failed and need to be serviced.
- Improved remote administration control allows users to reboot and power-cycle in a "lights out" environment.
- SunVTS allows users to perform UNIX®-level diagnostics.

Replacing Failed CPU/Memory or I/O Boards

- If an UltraSPARC module, SIMM, CPU/memory board, or I/O board fails, the system attempts to recover without any service interruption. In some cases, the failure requires a reboot. In these situations, the failed component will be configured out of the system during the reboot sequence.
- After the failed CPU/memory or I/O board is deconfigured from the system, the failed board may be removed and replaced while the system is online. The system must be rebooted to configure the new board into the system. This can be scheduled to take place when rebooting has a minimum impact on users.
- If an UltraSPARC module fails, either the UltraSPARC module or the CPU/memory board can be deconfigured during the reboot sequence, as defined by the user.
- With a future version of Solaris, rebooting after the CPU/memory board has been installed will not be required. The system will be able to configure the board into the system while staying online. This feature is known as Dynamic Reconfiguration.

Adding Additional CPU/Memory or I/O Boards

- Hot-plug capability makes adding additional UltraSPARC modules or memory much easier and faster.
- To add additional boards, simply configure a board as required and install the board while the system is running. Reboot the system to configure the new board into the system. Rebooting can be scheduled for a time that will cause minimum impact on users.
- With a future version of Solaris, rebooting will not be required when adding CPU/memory boards. The system will be able to configure the board into the system while staying online. This feature is known as Dynamic Reconfiguration.

Built-in RAS Features in the Enterprise Servers

Hot-Plug Components

- Hot-plug CPU/memory boards make it easy to replace failed boards or to increase the performance of the system.
- Hot-plug disk drives (using a SPARCstorage RSM disk tray of the SPARCstorage Array Model 200 RSM series) make it easy to replace failed disk drives or to increase storage capacity.
- Hot-plug power/cooling units make it easy to replace failed power/cooling units, or to upgrade the power/cooling capacity of the system.

Redundant Components

- Redundant power supplies and current-sharing power circuitry keep the system running if a power supply fails.
- Redundant CPU modules and CPU/memory boards enable immediate recovery from a failure.

Redundant fans keep the server cool if a fan fails.**High Availability**

- Multiple CPU modules maximize uptime if a CPU fails.
- Multiple CPU/memory boards maximize uptime if a CPU/memory board fails.
- Multiple I/O boards maximize uptime if an I/O board fails.
- Enhanced automatic system recovery (ASR) quickly configures the system around the failed component.
- Dual variable-speed fans in each power/cooling unit keep the system cool if one fan within a power/cooling unit fails.
- Remote administration control allows remote reboots and power-cycling.
- CPU Power Control (Solaris 2.6) removes an active CPU from system configuration and powers it off if environmental sensors sense the system is running too hot due to a cooling problem. This is done without any interruption to running processes and without a reboot of the server.

High Reliability

- Modular system design makes it easy to replace failed components.
- Passive centerplane bus increases mean time between failures (MTBF) of the system.
- FCC-protected data throughout the system increases data integrity.
- Parity protection of the address and control signals throughout the system increases the integrity of these signals.
- Fewer active components than previous-generation servers increase the MTBF of the system.
- Improved system diagnostics minimize downtime.

Overview

The Ultra™ Enterprise™ 4000, 5000, and 6000 servers are designed around a centerplane, with system slots in both the front and rear. Each slot can accommodate either a CPU/memory, I/O, or disk board. Almost any combination of boards is allowed, as long as the required minimum of one CPU/memory board and one I/O board is met. One I/O board must be inserted into slot 1 in order to provide the SCSI connection to the CD-ROM drive and the optional internal tape device. In addition, the Enterprise 4000 and 5000 support a maximum of four disk boards, while the Enterprise 6000 supports a maximum of two disk boards.

The Enterprise 3000 is the smallest member of the Enterprise X000 family. Because it has only four slots, there is little need for a centerplane arrangement. The centerplane arrangement allows for larger configurations in less physical space. Intended as a deskside system, the Enterprise 3000 uses a traditional backplane configuration with all four boards plugged into one side of the system. The Enterprise 3000 also has internal mounting for up to ten 3.5 x 1-inch or 3.5 x 1.6-inch disks, along with CD-ROM and tape drives.

Each CPU/memory board supports up to two UltraSPARC™ modules and 2 GB of memory (see “CPU/Memory Board” in this section for more details). SBus I/O boards support fast/wide SCSI, 10/100-Mb Ethernet, either two Fibre Channel connections (2610A) or two empty FC-AL sockets (2611A), and multiple SBus slots (see “I/O Boards” in this section for more details). PCI I/O boards support fast/wide SCSI, 10/100-Mb Ethernet, and multiple PCI slots. CPU/memory boards, I/O boards, power/cooling modules, and clock boards are interchangeable within the Enterprise 3000–6000 product line.

Overview *(cont.)*

The clock board contains the keyboard and mouse port, two serial ports, time-of-day clock, and the IDPROM. The frequency of the clock, the processor clock, and the system clock are all programmable through firmware.

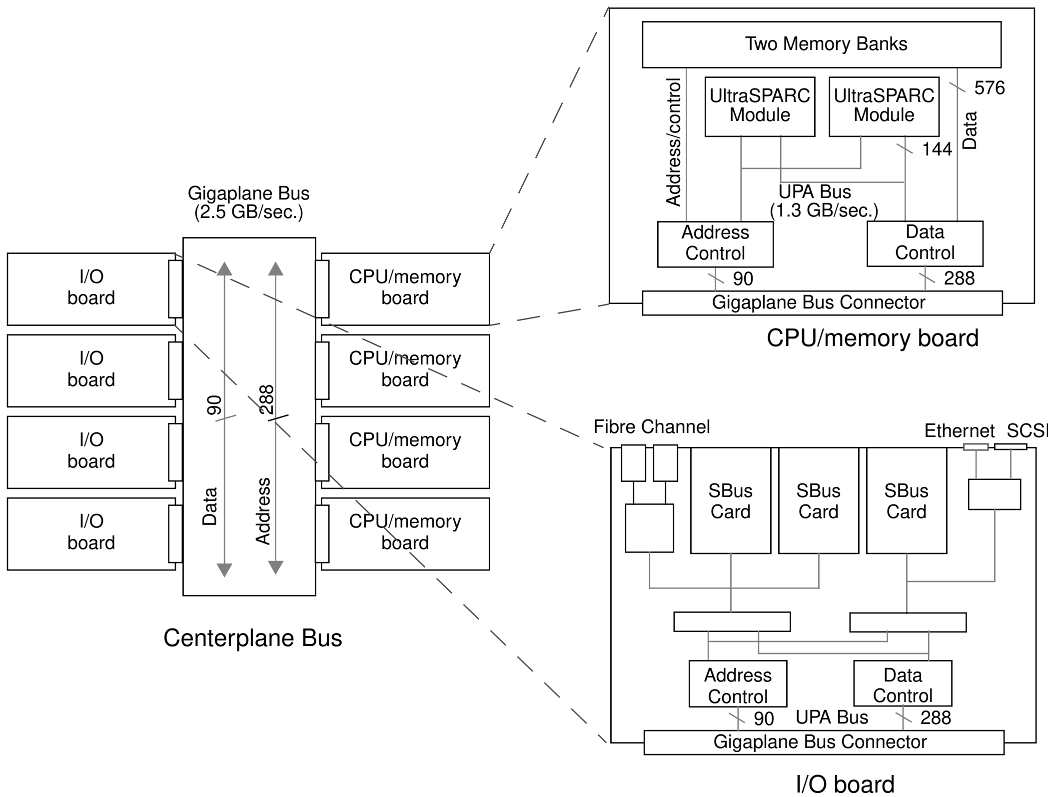


Figure 1. Enterprise 3000–6000 system bus architecture

System Bus

The system bus for the Enterprise 3000–6000 servers is the Gigaplane™ bus, an 83 or 84-MHz, packet-switched bus. The bus is a split-transaction design with separate buses for address and data. The maximum throughput is 2.6 GB/sec., with a sustained throughput of 2.5 GB/sec. This is approximately eight times the throughput available on a single XDBus™ used in the SPARCserver™ 1000E.

The Ultra Port Architecture (UPA) bus, the primary bus for the Ultra™ 1 desktop workstation, is used as an intermediate bus connecting CPU/memory boards and I/O boards to the Gigaplane bus. The UPA bus also runs at 83 or 84-MHz, with a peak throughput of 1.3 GB/sec.

Reducing the memory latency of the system bus was one of the primary system bus design goals. The memory latency for the Enterprise 3000–6000 servers is approximately one-fourth the memory latency of the SPARCcenter™ 2000E. This reduction was the result of the following design changes:

- **Separate address, data, and control signals.** In the SPARCserver 1000E, the address and data shared the same bus. In the Enterprise 3000–6000, the address and data use separate buses. This allows read requests to be transmitted on the address bus at the same time data from the previous read request is being transmitted on the data bus.
- **Wider data buses.** The data buses throughout the Enterprise 3000–6000 servers are two to four times wider than the data buses in the SPARCserver 1000E systems.

Table 6:

Data Bus	Enterprise 3000–6000	SPARCserver 1000E	Difference compared to SPARCserver 1000E	SPARCcenter 2000E	Difference compared to SPARCcenter 2000E
Memory data bus	576 bits	72 bits	8x	144 bits	4x
Data bus	288 bits	72 bits	4x	72 bits	2x
CPU data bus	144 bits	64 bits	2x	64 bits	2x

- **Faster bus.** The Gigaplane bus, which runs at 83 or 84-MHz, is faster than the XDBus, which runs at 50 MHz.
- **Enhanced arbitration cycles.** Zero cycle arbitration mode, used in certain situations, greatly reduces bus arbitration time. Additionally, by using two cycle address and data packets (versus two to nine cycles on the SPARCserver 1000E), devices have much less time to wait in order to get on the bus.
- **Faster memory response.** A number of techniques are employed to get a faster response to data requests:
  - 576-bit wide memory
  - 16-way memory interleave
  - Read bypass writes in memory controller
  - Queue bypasses for requests and data
  - Writebacks handled after miss

System Bus RAS Features

The following four attributes of the system bus architecture contribute to many of the RAS features of the Enterprise 3000–6000 servers:

- **Passive backplane system bus**. A passive backplane bus minimizes the number of active components required to control the bus. This results in a more reliable system.
- **Sturdy connectors and better board-insertion guides**. The SPARCserver 1000E has 100 pins on a connector. The Enterprise 3000–6000 servers are much sturdier, with 450 pins on a connector that is only twice the size of the SPARCserver 1000E connector. The sturdier connectors, combined with better guides for board insertion, minimize the chance of the system being disabled due to bent pins from a faulty board insertion.
- **ECC-protected data paths**. All the data paths in the Enterprise 3000–6000 are fully protected by error checking and correction (ECC), which is able to detect single- and double-bit errors and to correct single-bit errors.
- **Parity-protected address and data paths**. All the address and data paths in the Enterprise 3000–6000 are protected by parity.

System Bus Q&A

Q. Why didn't Sun use crossbar bus technology in the Enterprise 3000–6000 server as in the Ultra 1 desktop workstation?

A. The crossbar bus used in the Ultra 1 desktop workstation supports a maximum of four devices. The Enterprise 4000 and 5000 have eight slots and the Enterprise 6000 has 16 slots, with multiple devices per slot. Perhaps more importantly, crossbar bus technology was not needed for the Enterprise 4000–6000 centerplane bus because the Gigaplane bus is fast enough, at 2.5 GB/sec., to support 30 CPUs without the use of crossbar technology. (This design was later modified for the Enterprise 3000).

The Gigaplane bus provides 2.5 GB/sec. of sustained throughput, making it suitable for large symmetrical multiprocessor (SMP) servers. The Gigaplane bus is able to support up to sixteen boards in the Enterprise 6000. Each board contains a UPA bus that connects to the Gigaplane bus and "multiplexes" the associated component loads, such as CPU and SBus, onto a single connection to the Gigaplane bus. This design is able to support many more CPU and SBus slots than if they were connected directly to the Gigaplane bus.

Q. Will there be a latency penalty for memory access relative to the single-level bus implementation of the Ultra 1 desktop?

A. There will be some penalty, but exceptional effort has gone into minimizing this penalty. Relative to the Ultra 1 desktop, the penalty for access to the first word in a data request is five clock cycles, or 60 ns. This decreases to two clock cycles (or 24 ns) by the last word in a data request. This minimal latency penalty should be imperceptible to the user, as it was in the XDBus-based systems.

System Bus Q&A *(cont.)*

Q. How can the sustained data transfer rate on the Gigaplane bus be so close to the peak bandwidth? Is this a misprint?

A. There are two reasons why the sustained data transfer rate (2.5 GB/sec.) on the Gigaplane bus is so close to the peak bandwidth (2.6 GB/sec.). The first is separate address and data buses. With separate address and data buses, data requests can be sent out on the address bus at the same time that data from a previous data request is on the data bus. The second is out-of-order data transmission, which allows data to be put on the data bus in a different order than requested. This helps maximize the bus usage by minimizing unused data bus bandwidth.

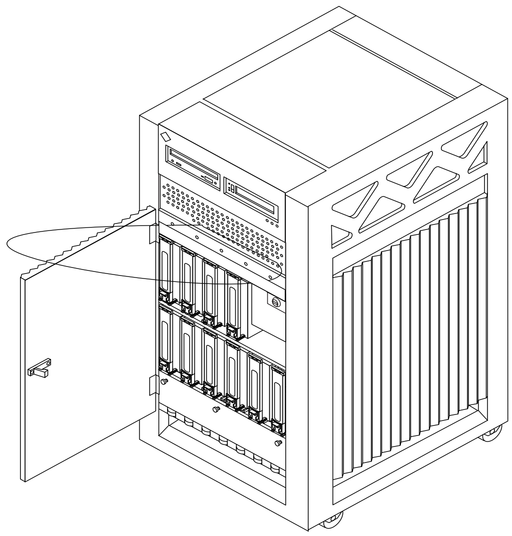
Q. Why did Sun move from a backplane to a centerplane design?

A. The centerplane design allows the system to support twice as many boards for a given length of system bus. This reduced length translates into an electrically shorter bus than would be possible with a backplane. This is important because bus speed (frequency) is, in part, determined by bus length. All other things being equal, the shorter the bus, the faster it can run.

The more densely packed centerplane also allows for more compact packaging. With this configuration, the Enterprise 4000 server can support eight slots with a smaller footprint than the SPARCserver 1000E that supports four slots. Also, the Enterprise 6000 server can support 16 slots in the same size data center cabinet that supports a ten-slot SPARCcenter 2000E.

Q. What happens if there isn't an I/O board in slot 1? Will the system be functional?

A. Yes, it will be fully functional, with the exception that the internal CD-ROM and tape drives won't be accessible.



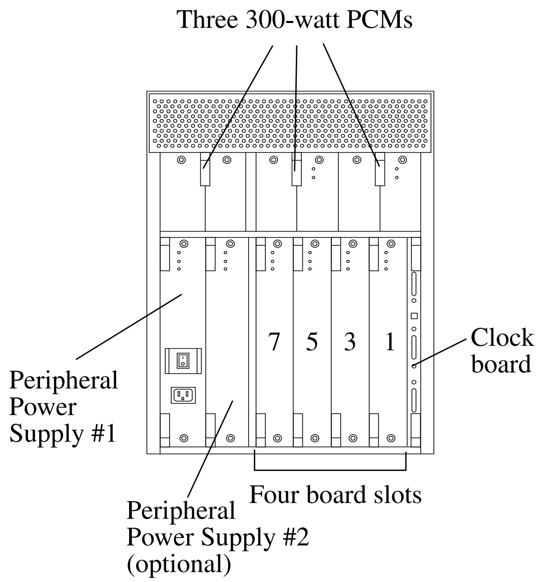


Figure 1. Enterprise 3000 cabinet

Enterprise 3000 System Cabinet

The Enterprise 3000 is a deskside tower enclosure, measuring approximately 65 cm x 43 cm x 44 cm (65 cm x 43 cm x 60 cm with the rear bumper which protects the cables.)

- A hinged door, covering the lower three-quarters of the cabinet, offers easy access to internal disk drives and the key switch.
- Two built-in disk bays hold up to ten internal hot-plug disk drives. A single fast/wide SCSI chain supports all drives. Customers needing greater availability should purchase the Enterprise 4000 with the SPARCstorage™ RSM™.
- A SunCD™ 12 CD-ROM drive is installed in the upper right of the cabinet.
- An optional tape drive may be installed to the left of the CD-ROM drive. The tape drive can be a 4-mm, 8-mm, or 1/4-inch tape drive.
- The key switch is located behind the door in the upper-right corner.
- There are four slots in the bottom portion of the cabinet for CPU/memory boards and I/O boards. The slots are numbered 1, 3, 5, and 7, from right to left.
- The Enterprise 3000 comes with one power/cooling module (PCM) located above slots 1 and 3. If a second PCM is required, it would fit above slots 5 and 7, to the left of the first PCM.
- A fan tray above the peripheral power supplies is also included in an entry configuration.
- A third PCM can be used for redundant power in a fully loaded system. To install the third PCM, the existing fan tray, located to the left of the second PCM, must be removed. The third PCM fits into this slot.
- The peripheral power supply is located in the lower left of the cabinet rear. A spot for a redundant peripheral power supply is located to the right of the first peripheral power supply.
- The clock board is located in the lower right, next to board slot 1. The clock board has its own slot and does not use one of the four slots for the CPU/memory or I/O boards.

External Mass Storage

External mass storage devices may be attached to the Enterprise 3000 server, although it is not recommended. As previously mentioned, the Enterprise 3000 is designed to be a single-enclosure system. If the internal capacity of the Enterprise 3000 is insufficient for the customer, then the Enterprise 4000 should be considered. In those situations, the Enterprise 4000 would most likely be better suited for the customer's computing and data storage needs.

Some customers may insist on attaching external mass storage devices. For example, some may want to attach up to four SPARCstorage™ Array Model 100 Series on a stacking unit. This yields 250 GB of storage. If the customer wishes to attach an even larger data expansion unit, such as the SPARCstorage Array Model 200 RSM Series, it is supported, although a larger Enterprise family system is recommended. When applications require over 250 GB of storage, they would most likely also require computing power in excess of what the Enterprise 3000 offers.

Work with the customer to ensure that the configured server can satisfy all of the customer's storage and computing requirements, while still leaving room for growth.

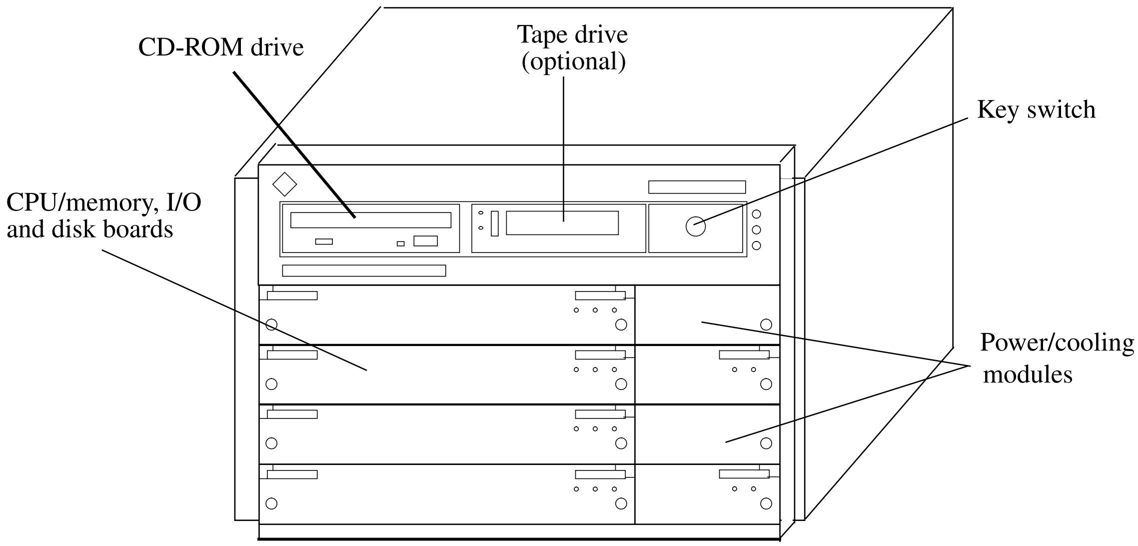


Figure 2. Enterprise 4000 system cabinet

Enterprise 4000 System Cabinet

The Enterprise 4000 server package is a tabletop enclosure, similar in size to the external package of the SPARCserver 1000E.

- Inside the enclosure is an eight-slot card cage for CPU/memory, I/O, or disk boards, allowing four boards to be installed from the front of the cabinet and four boards to be installed from the rear. Typically, the I/O boards and disk boards will be installed from the rear for ease of cabling.
- In the card cage, next to the board slots, are slots for the power/cooling modules. Up to four power/cooling modules can be installed, two from the front and two from the rear. Power/cooling modules must be installed adjacent to CPU/memory, I/O, and disk boards.
- The peripheral power supply is located at the top rear of the card cage.
- The SunCD 12 CD-ROM drive is located at the upper left front of the enclosure. Next to the SunCD 12 is a slot for an optional half-height tape device. The tape device can be a 4-mm, 8-mm, or 1/4-inch tape drive. Next to the slot for the optional tape device are the key switch and system LEDs.
- The clock board is located in the card cage below the peripheral power supply. The clock board has its own slot and does not use one of the eight board slots for the CPU/memory, I/O, or disk boards.

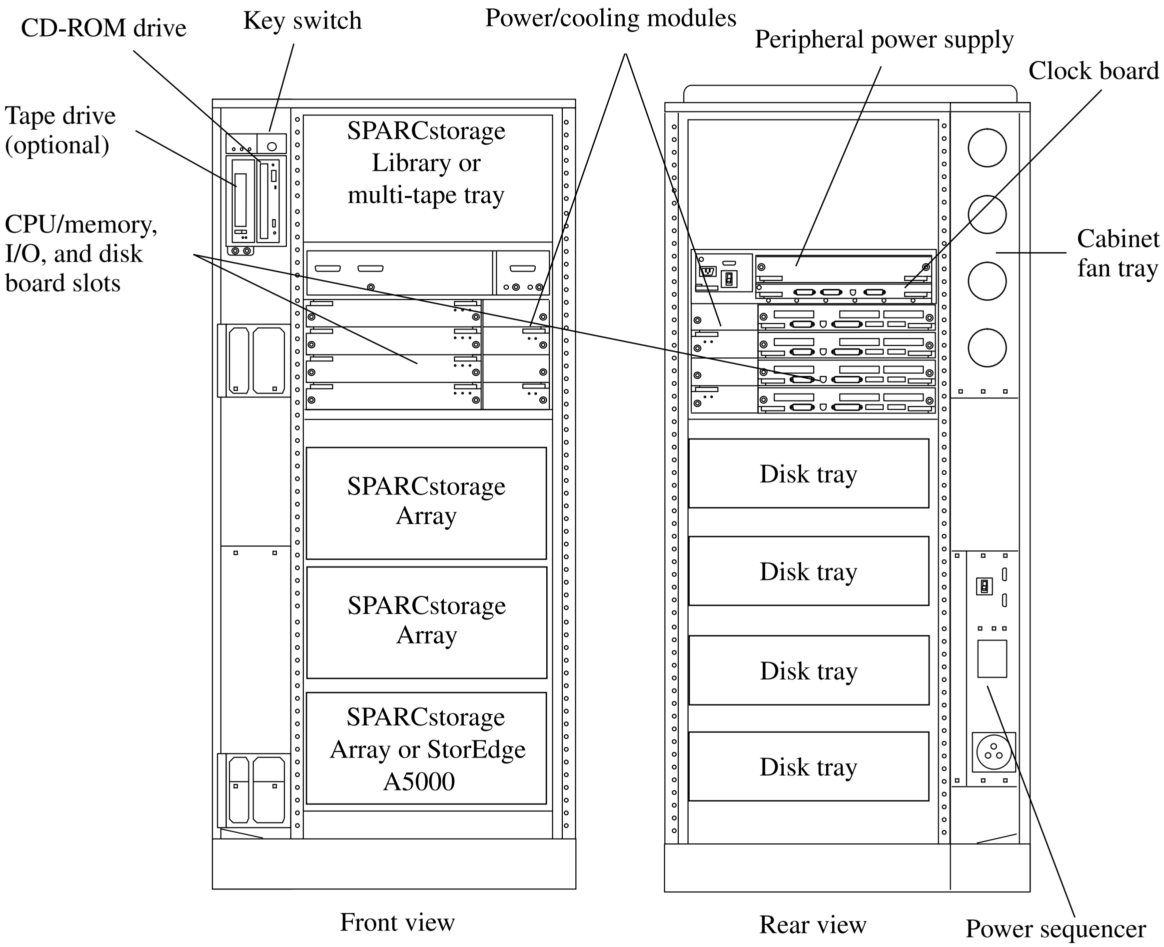


Figure 3. Enterprise 5000 system cabinet

Enterprise 5000 System Cabinet

The Enterprise 5000 system enclosure is a 56-inch data-center cabinet, the same size as the SPARCcenter 2000E system cabinet.

- Inside the cabinet is an eight-slot card cage for CPU/memory, I/O, or disk boards, allowing four boards to be installed from the front of the cabinet and four boards to be installed from the rear. Typically, the I/O boards and disk boards will be installed from the rear for ease of cabling.
- In the card cage, next to the board slots, are slots for the power/cooling modules. Up to four power/cooling modules can be installed, two from the front and two from the rear. Power/cooling modules must be installed adjacent to CPU/memory, I/O, and disk boards.
- The peripheral power supply is located at the top rear of the card cage.
- The clock board is located in the card cage below the peripheral power supply. The clock board has its own slot and does not use one of the eight board slots for the CPU/memory, I/O, or disk boards.
- An optional multi-tape tray or SPARCstorage Library can be installed above the card cage.
- The cabinet fan tray contains four fans that blow hot air out the rear of the cabinet.

Enterprise 5000 System Cabinet *(cont.)*

- The following devices can be installed in the system cabinet below the card cage:
  - One StorEdge A5000 and up to two other peripherals (except other A5000's)
  - One to three SPARCstorage Array Model 100 series subsystems
  - One to four SPARCstorage RSM disk trays or differential SCSI disk trays
  - One SPARCstorage Array Model 100 series subsystem, and two SPARCstorage RSM disk trays or differential SCSI disk trays
  - Two SPARCstorage Array Model 100 series subsystems, and one SPARCstorage RSM disk tray or differential SCSI disk tray
  - One Ultra Enterprise 4000 (using the Enterprise 4000 Rack-Mount Rails)
- A hinged door covering the lower three-quarters of the cabinet offers easy access to internal components.
- A SunCD 12 CD-ROM drive is installed in the upper left front of the system cabinet. Next to the SunCD 12 is a slot for an optional half-height tape device. The tape device can be a 4-mm, 8-mm, or 1/4-inch tape drive. Next to the slot for the optional, half-height tape device are the key switch and system LEDs. The SunCD 12 CD-ROM, the optional tape device, and the key switch are mounted behind a separate, small door.
- The top panel does not have a hinged door as on the SPARCcenter 2000E. The upper right front of the system cabinet will either have a bezel for the multi-tape library or SPARCstorage Library, or a blank panel when no peripherals are installed above the card cage.

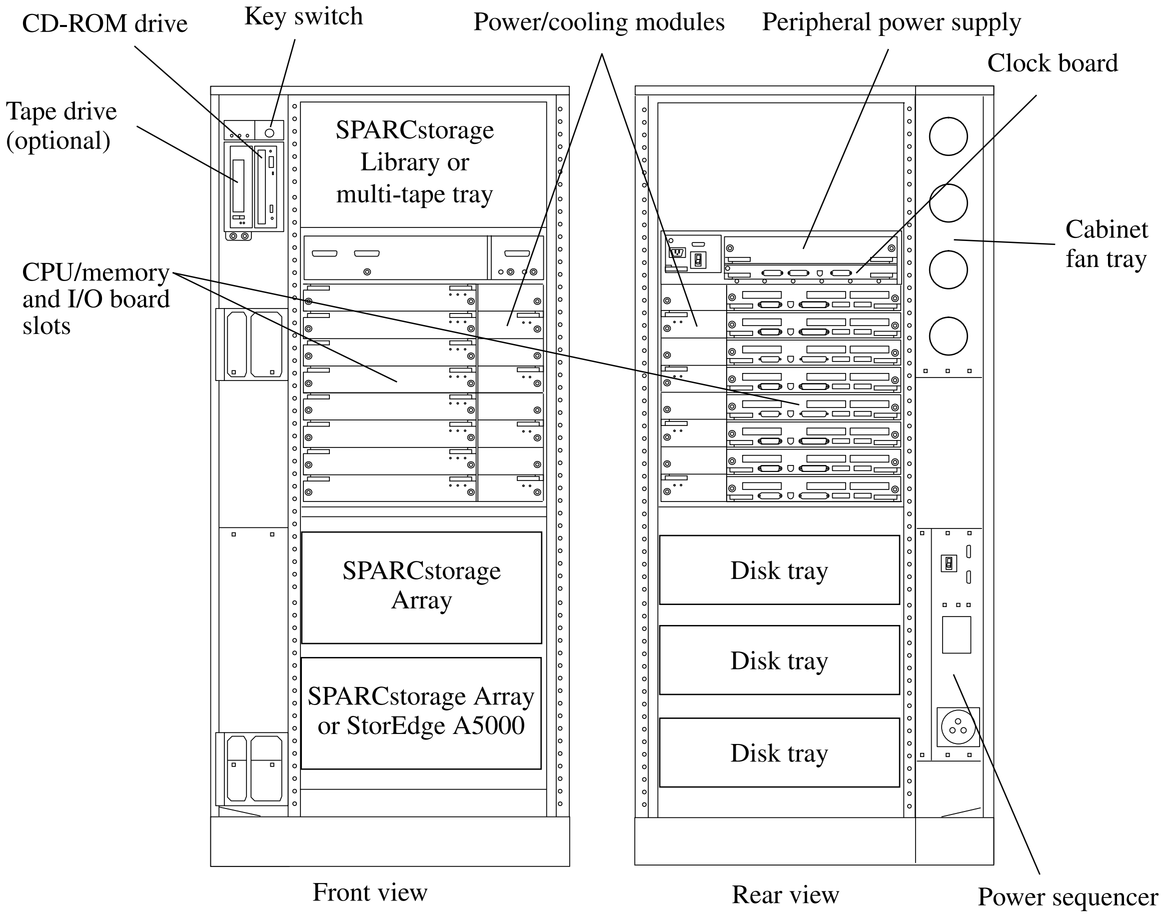


Figure 4. Enterprise 6000 system cabinet

Enterprise 6000 System Cabinet

- The Enterprise 6000 system enclosure is a 56-inch data-center cabinet, the same size as the SPARCcenter 2000E system cabinet.
- Inside the cabinet is a 16-slot card cage for CPU/memory boards, I/O boards and disk boards, allowing eight boards to be installed from the front of the cabinet and eight boards to be installed from the rear of the cabinet. Typically, the I/O boards will be installed from the rear for ease of cabling.
- In the card cage, next to the board slots, are slots for the power/cooling modules. Up to eight power/cooling modules can be installed, four from the front and four from the rear. Power/cooling modules must be installed adjacent to CPU/memory and I/O boards.
- The peripheral power supply is located at the top rear of the card cage.
- The clock board is located in the card cage below the peripheral power supply. The clock board has its own slot and does not use one of the 16 board slots for the CPU/memory, or I/O boards.
- An optional multi-tape tray or SPARCstorage Library can be installed above the card cage.
- The cabinet fan tray contains four fans that blow hot air out the rear of the cabinet.

Enterprise 6000 System Cabinet *(cont.)*

- The following storage devices can be installed in the system cabinet below the card cage:
  - One StorEdge A5000 and up to one other peripheral
  - Up to two SPARCstorage Array Model 100 series subsystems
  - Up to three SPARCstorage RSM disk trays
  - Up to three differential SCSI disk trays
  - One SPARCstorage Array Model 100 series subsystem and one SPARCstorage RSM disk tray or differential SCSI disk tray
- A hinged door covering the lower three-quarters of the cabinet offers easy access to internal components.
- A SunCD 12 CD-ROM drive is installed in the upper left front of the system cabinet. Next to the SunCD 12 is a slot for an optional half-height tape device. The tape device can be a 4-mm, 8-mm, or 1/4-inch tape drive. Above the slot for the optional half-height tape device is the key switch.The SunCD 12 CD-ROM, the optional tape device, and the key switch are mounted behind a separate, small door.
- The top panel does not have a hinged door as on the SPARCcenter 2000E. The upper right front of the system cabinet will either have a bezel for the multi-tape library or SPARCstorage Library, or a blank panel when no peripherals are installed above the card cage.

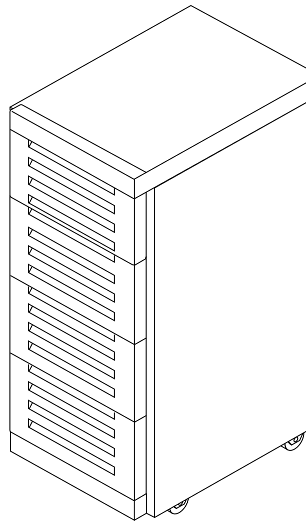


Figure 5. The Enterprise Expansion Cabinet

Enterprise Expansion Cabinet

The Enterprise expansion cabinet is used with the Enterprise 4000–6000 servers. This cabinet is a 56-inch datacenter cabinet, similar in look and size to the Enterprise 5000 and 6000 system cabinets.

Each expansion cabinet includes a cable for connecting the expansion cabinet to a system cabinet. The cable allows control and status information to be transferred between the expansion cabinet and the system cabinet. (See “Expansion Cabinet Cooling” in this section for more details.) Multiple expansion cabinets can be daisy-chained to the system cabinet.

- The expansion cabinet can be configured to a user’s specific needs. The following devices may be installed in an expansion cabinet:
  - StorEdge A5000
  - SPARCstorage Array Model 100 Series
  - SPARCstorage Array Model 200 Series Controller
  - SPARCstorage RSM trays
  - Differential SCSI disk trays
  - Multi-tape backup trays
  - SPARCstorage Library Model 8/140 and 8/400
  - Ultra Enterprise 4000 server
- The expansion cabinet has a full-height hinged door, offering easy access.
- Enterprise cabinet floor brackets may be installed to help prevent the cabinet from shifting in cases of extreme floor movement.

Expansion Cabinet Capacity

- A maximum of four StorEdge A5000's can be installed in an expansion cabinet, offering a maximum of 509.6 GB of storage.
- A maximum of four SPARCstorage Array Model 100 Series disk arrays can be installed in an expansion cabinet, offering maximum capacity of 252 GB.
- A maximum of eight differential SCSI disk trays are supported per cabinet. Each differential SCSI disk tray supports up to six 9-GB disk drives, offering a maximum capacity of 432 GB.
- A maximum of eight SPARCstorage RSM trays are supported per cabinet. Each SPARCstorage RSM disk tray supports up to seven 4.2-GB or 9.1-GB disk drives, offering a maximum capacity of 235 GB or 509 GB respectively.
- A maximum of two multi-tape backup trays are supported per expansion cabinet; a maximum of five multi-tape backup trays are supported per system.
- Up to four tape devices are supported per multi-tape backup tray.
- A maximum of four SPARCstorage Library Model 8/140s or 8/400s are supported per expansion cabinet; a maximum of nine SPARCstorage Library Model 8/140s or 8/400s are supported per system.
- Expansion cabinets with multi-tape backup trays or SPARCstorage Libraries must be adjacent to the system cabinet. This is required because the maximum length of the single-ended SCSI cable is 6 meters.
- The RSM Array 2000 is a pre-configured cabinet that includes five RSM disk trays and the highest RAS features while providing superior RAID 3 and RAID 5 performance relative to other alternatives. Maximum capacity is 147 GB with 4.2-GB drives and 318 GB with 9.1-GB drives.
- The SPARCstorage Array Model 219 RSM Series is a pre-configured expansion cabinet that includes six SPARCstorage Array RSM trays and offers a maximum capacity of 382 GB. The two top disk tray slots are occupied by the SPARCstorage Array series controller.
- The SPARCstorage Array Model 214 RSM Series is a pre-configured expansion cabinet that includes six SPARCstorage Array RSM trays, offering a maximum capacity of 176 GB. The two top disk tray slots are occupied by the SPARCstorage Array 200 Series Controller.
- The SPARCstorage Array Model 200 Series supports up to six differential SCSI disk trays, offering a maximum capacity of 324 GB. The two top disk tray slots are occupied by the SPARCstorage Array 200 Series Controller.

Enterprise Expansion Cabinet *(cont.)*

Expansion Cabinet Capacity *(cont.)*

- Up to three Enterprise 4000 servers may be mounted in an Enterprise expansion cabinet with the Enterprise 4000 rack-mount rails.

  The following combinations of rack-mounted devices are supported with *one* Enterprise 4000 server in the Enterprise expansion cabinet:
  - One StorEdge A5000
  - Up to three SPARCstorage Array Model 100 Series or
  - Up to two SPARCstorage Array Model 100 Series and one tape unit or
  - One SPARCstorage Array Model 100 Series and two tape units

  SPARCstorage Array Model 100 Series and tape unit enclosures can be replaced with disk trays as follows:
  - One enclosure can be replaced with one disk tray
  - Two enclosures can be replaced with three disk trays

  The following combinations of rack-mounted devices are supported with *two* Enterprise 4000 servers in the Enterprise expansion cabinet:
  - One StorEdge A5000
  - One SPARCstorage Array Model 100 Series or
  - One tape unit or
  - Up to two disk trays

  No additional devices can be mounted in a Enterprise expansion cabinet with three Enterprise 4000 servers. The Ultra Enterprise cabinet air baffle is required when three Enterprise 4000 chassis are installed in an Enterprise expansion cabinet. This air baffle is required in order to ensure proper cooling for the cabinet. The air baffle is not required when only one or two Enterprise 4000 servers are mounted in a single Enterprise expansion cabinet.

Expansion Cabinet Cooling

- Each expansion cabinet has one cabinet fan tray that includes four fans supported by two power supplies. Each power supply supports two fans.
- The expansion cabinet features redundant cooling. If a power supply fails, two fans stop running and two fans continue to operate, providing enough cooling to keep the devices in the expansion cabinet cool.
- Expansion cabinets can be controlled by the Enterprise 4000–6000 and can send status information to the system cabinet, through a connection between the expansion cabinets and the system cabinet. Specifically, the connection supports the following:
  - When a cabinet fan tray fails in an expansion cabinet, the Enterprise 4000–6000 is notified of this failure. A system administrator monitoring the Enterprise 4000–6000 status will be able to see when a cabinet fan tray fails in an expansion cabinet.
  - The system administrator is able to turn off the Enterprise 4000–6000 and all the expansion cabinets connected to the Enterprise 4000 with either the Enterprise 4000–6000 key switch or through a software command.

Expansion Cabinet Q&A

Q. What is the difference between the SPARCcenter expansion cabinet and the Enterprise expansion cabinet?

A. In general, these two expansion cabinets offer similar storage capacity. Here are the differences:

- The Enterprise expansion cabinet is able to communicate with the Enterprise 4000–6000 system over a dedicated connection, transferring status and control information between the two cabinets. Specifically, the Enterprise 4000–6000 is notified, using the dedicated connection, if the cabinet fan tray fails in an Enterprise expansion cabinet. A system administrator monitoring the Enterprise 4000–6000 will be notified of the cabinet fan tray failure. Additionally, the system administrator is able to turn off the expansion cabinet either by using the key switch in the Enterprise 4000–6000 or by issuing a software command.
- The Enterprise expansion cabinet offers redundant cooling, whereas the SPARCcenter expansion cabinet does not.
- The Enterprise expansion cabinet does not support a half-inch tape drive, whereas the SPARCcenter expansion cabinet does.
- Internally, the Enterprise expansion cabinet's fan tray is on the left side (facing the rear), whereas the SPARCcenter expansion cabinet's fan tray is on the right.
- The Enterprise expansion cabinet uses the same color and "look" as the Enterprise 5000 and 6000 system cabinets.
- The Enterprise expansion cabinet supports up to three rack-mounted Enterprise 4000 servers. The SPARCcenter expansion cabinet does not support any Enterprise 4000 servers.

Q. Can I migrate the peripherals in my existing SPARCcenter expansion cabinet and move them to the new Enterprise expansion cabinet?

A. Yes, you can migrate the peripheral devices in the SPARCcenter expansion cabinet to the Enterprise expansion cabinet. The only device supported in the SPARCcenter expansion cabinet that is not supported in the Enterprise expansion cabinet is the half-inch tape drive.

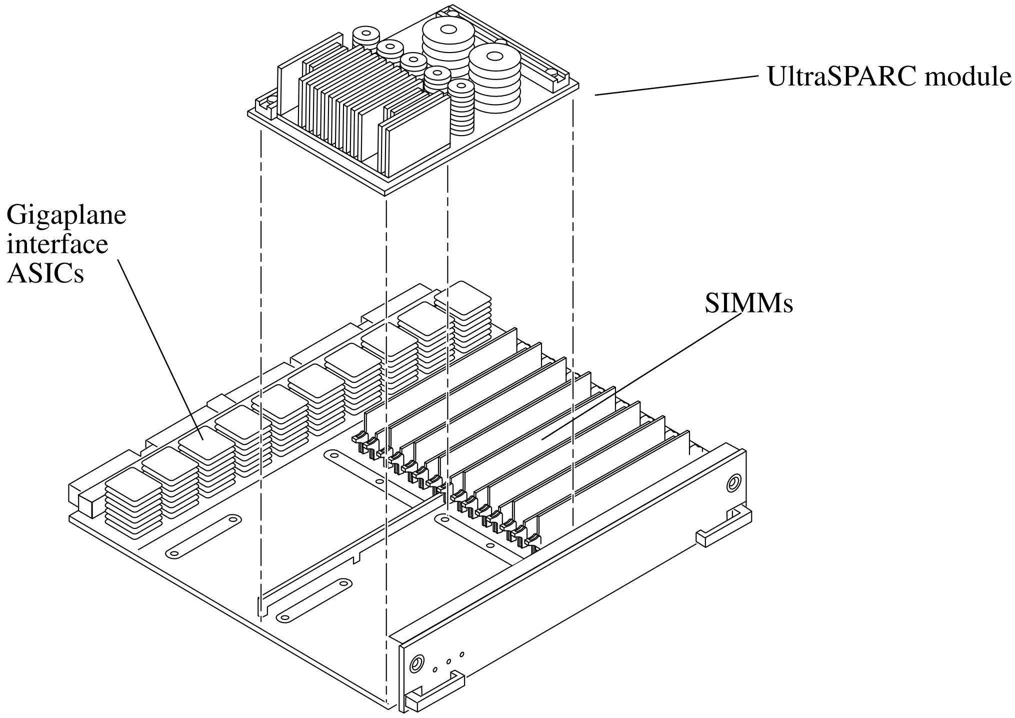


Figure 7. CPU/memory board

CPU Memory Board

CPU/memory boards connect to the Gigaplane bus. On the CPU/memory boards, the UPA bus connects the Gigaplane bus to the two UltraSPARC modules and two memory banks.

- Each CPU/memory board can support zero, one, or two UltraSPARC modules. CPU/memory boards with no UltraSPARC modules can be added to systems requiring more memory capacity.
- Enterprise 3000–6000 servers support 167-MHz , 250-MHz and 336-MHz UltraSPARC modules.
- The CPU/memory board has two banks of 60-ns, 3.3-V SIMMs. Each memory bank consists of eight SIMMs. Three types of memory options are available: 64 MB (8 x 8-MB SIMMs), 256 MB (8 x 32-MB SIMMs), and 1 GB (8 x 128-MB SIMMs).
- Each CPU/memory board supports up to 2 GB of memory.
- The CPU/memory boards have temperature sensors located under the UltraSPARC modules that control the fan speed in the adjacent power/cooling module and allow the actual temperature of individual boards to be monitored through Solstice™ SyMON™.
- With a system design that supports multiple CPU/memory boards, a failure of a single UltraSPARC module or SIMM will result in a temporary interruption of system operation while the system reboots itself around the failed component.

CPU/Memory Board Q&A

Q. Why did Sun change from using a single system board that included everything (CPU, memory, and I/O) to offering two types of boards, CPU/memory boards and I/O boards?

A. There are many advantages gained by offering separate CPU/memory boards and I/O boards. The primary advantage is configuration flexibility. With one system board, a customer who wants to increase memory capacity must purchase an entire system board. With separate CPU/memory and I/O boards, customers can purchase only what they need. If they want to add additional memory, they purchase a CPU/memory board. This allows customers to configure systems as computing engines or I/O engines, which are not only less expensive, but also offer much higher performance, since they can configure more CPUs (and memory) or more I/O bandwidth, depending upon their application needs.

Another reason is design flexibility. With separate CPU/memory and I/O boards, Sun can make modifications to each type of board independently. For example, Sun can upgrade the Fibre Channel Interface on the I/O board and not affect the CPU/memory board. Ultimately, this allows Sun to bring out new CPU/memory and I/O board modifications, as well as new technologies, more quickly.

In addition, since the I/O board has much more functionality than before, one I/O board in the Enterprise 4000 has the same I/O capability as two system boards in the SPARCserver 1000E. This means Sun offers greater CPU, memory, and I/O expandability in these system by offering separate CPU/memory and I/O boards.

Q. Can I insert and remove UltraSPARC modules myself?

A. No, only qualified personnel should insert and remove UltraSPARC modules.

Q. Why did Sun go to a new UltraSPARC module connector?

A. The new connector is more reliable than the connector used in the SPARCserver 1000E.

Q. What is required to upgrade from 167-MHz to 250-MHz or 336-MHz UltraSPARC modules?

A. The clock board upgrade is required when the 250-MHz or 336-MHz modules are installed in systems ordered with the original Server Base package numbers (EX000). Factory-configured 250-MHz and 336-MHz modules can be ordered only with the new Server Base packages(EX002). The EX001 and EX002 base packages include the new clock board which supports the 167-MHz, 250-MHz, and 336-MHz modules.

Q. Are mixed-speed modules supported?

A. No, mixed-speed modules are not supported. Customers are required to replace all of their UltraSPARC modules with the higher speed UltraSPARC modules to take advantage of the faster CPUs.

Q. Can I mix same-speed UltraSPARC modules with different size external cache?

A. Yes; however, all modules on a single CPU/memory board must have the same size external cache.

CPU/Memory Board Q&A

Q. What is the software requirement for the new 336-MHz modules?

A. The 336-MHz UltraSPARC module requires Solaris™ 2.5.1 or later. It also requires Ultra Enterprise Flashprom Update 3.2.12 or later. The Flashprom Updates can be found on the SunSolve website: http:://sunsolve.Corp.Sun.COM/

Q. Are there any special requirements for upgrading to the 250-MHz/4-MB or 336-MHz,/4-MB UltraSPARC modules?

A. Yes, these modules should be installed on the newer CPU/memory board 2601A. Although the module will function on the original CPU/memory board (2600A), only 2 MB of Ecache will be utilized per module.

Memory Subsystem

The memory in the Enterprise 3000–6000 servers is located on the CPU/memory boards. Up to 2 GB of RAM can be installed on each CPU/memory board. The memory subsystem in Enterprise 3000–6000 servers is designed to offer fast, reliable data access.

- The memory controller manages two banks of memory on each CPU/memory board. Each bank of memory consists of eight standard JEDEC SIMM modules, implemented in 3.3-V CMOS.
- The memory banks on the CPU/memory boards are very “wide.” Each bank can deliver 512 bits (64 bytes) in a single cycle, meaning that a 64-byte cache miss can be supplied in one memory cycle. This results in faster memory subsystem performance.
- Enterprise 3000–6000 servers support up to 16-way memory interleave. Extensive interleave is required to support the high memory access rates possible in systems with many UltraSPARC modules.
- Interleaved memory banks can be different sizes, which is different from the memory interleaving scheme used in the SPARCserver 1000E.

Memory Interleaving

Memory interleaving helps increase memory subsystem performance by reducing the probability of “hot spots” or contention in a few memory banks by spreading access to multiple memory banks. In a two-way interleaved system, the first cacheline is supplied by bank 0 while the second is supplied by bank 1. The size and extent of interleave is arranged so that a single typical request is satisfied by one bank. This permits memory requests to be fulfilled with a minimum amount of contention from other UltraSPARC modules.

Interleaved memory on Enterprise 3000–6000 systems is considerably more important than on previous-generation systems because the UltraSPARC modules generate requests faster and the bandwidth of a single bank of memory is a smaller fraction of the Gigaplane bus bandwidth.

Configuring Memory for Best Performance

Configuring the memory for optimal system performance is easier than doing so for the SPARCserver 1000E because the memory interleave algorithm used for Enterprise 3000–6000 is much more flexible. Here are some general guidelines that should be used as a starting point in configuring a memory subsystem:

- Each UltraSPARC module should have at least 128 MB of RAM.
- Spread the amount of memory equally among the available banks. If you have one 1024-MB bank and one 64-MB bank, 94 percent (1024 x 100 / (1024 + 64)) of all accesses on average will go to the 1024-MB bank and the bandwidth available will be limited by that bank, even though the 64-MB bank has the same available bandwidth. If most of the memory is in a few big banks, the interleaving of those big banks is more important than the interleaving of the other banks.
- In general, it is better to have more banks of smaller size than a smaller number of bigger banks.
- Fill up one bank on every board before filling the second bank on any board.
- If you have some boards with both banks filled and some boards with only one bank, put the smaller banks on the boards with two banks; keep the bigger banks on boards with only one bank.

Memory Subsystem Q & A

Q. What is the difference between the memory interleaving in the Enterprise 3000–6000 servers and the memory interleaving in the SPARCserver 1000E?

A. The SPARCserver 1000E system used a simple interleaving system that produced up to eight-way interleave. Enterprise 3000–6000 servers have an improved design with fewer restrictions on the interleave configuration. The previous-generation systems interleaved memory only when memory banks were the same size. This meant that a SPARCserver 1000E system with two 32-MB banks and two 256-MB banks would use a two-way interleave between the 32-MB banks and two-way interleave between the 256-MB banks.

A similarly configured Enterprise 3000–6000 server can use four-way interleave on the two 32-MB banks when combined with the first 32 MB of the 256-MB banks, and two-way interleave on the remaining memory. This permits considerably higher memory subsystem performance.

Q. Why can't the SIMMs from the SPARCcenter 2000E or SPARCserver 1000E be used in Enterprise 3000–6000 servers? The Ultra 1 systems use the SIMMs from the previous generation of desktops.

A. Enterprise 3000–6000 server architecture requires 3.3-volt SIMMs. All of Sun's previous generation SIMMs were 5-volt. In addition, the desktop SIMMs are too tall for the CPU/memory board spacing. The JEDEC SIMMs fit both the form factor and voltage requirements.

Q. Does the use of industry-standard SIMMs mean that customers can buy off-the-shelf SIMMs for use in Enterprise 3000–6000?

A. Yes, as long as the SIMMs are the correct size (density), form factor, and voltage. However, Sun cannot guarantee that SIMMs from third-party vendors will operate properly in Enterprise 3000–6000 servers. Sun does not support third-party memory options.

Q. Do Enterprise 3000–6000 servers need more memory per CPU compared to the SPARCcenter 2000E and SPARCserver 1000E? If so, why and how much?

A. Yes. With the SPARCcenter 2000E, the general rule is that each CPU should have at least 64 MB of RAM. With Enterprise 3000–6000 servers, the general rule is that each CPU should have at least 128 MB of RAM. The reason for more memory is that the UltraSPARC modules in the Enterprise 3000–6000 servers are much higher performance than the CPU modules in the SPARCcenter 2000E, so they require more memory for a balanced system.

Q. How can I tell what interleave factor an Enterprise 3000–6000 server is using?

A. You can use `prtdiag(1M)`, located in the `/usr/platform/sun4u/sbin` directory.

I/O Boards

Overview

Most of the I/O connectivity for Ultra Enterprise 3000–6000 servers is supported through I/O boards. Three types of I/O boards—SBus, SBus Graphics, and PCI—offer a wide range of I/O connectivity.

One of the significant improvements over the I/O subsystem in the SPARCserver 1000E is the use of dual SBus channels on each SBus I/O board. In the SPARCserver 1000E, each system board had one 32-bit SBus channel, offering a maximum I/O bandwidth of 100 MB/sec. per system board. With dual 64-bit SBus channels on each SBus I/O board, the maximum I/O bandwidth for an SBus I/O board in an Enterprise 3000–6000 server is 400 MB/sec.

The PCI I/O board has dual 528-MB/sec. PCI-66 (66-MHz, 64-bit) channels. Each channel leads to a PCI slot. There are also two 264-MB/sec. standard PCI channels. One channel leads to the on-board 10/100 Mbps Ethernet and the other leads to the on-board fast/wide SCSI (20 MB/sec.). The UPA interface that connects the PCI I/O board to the Gigaplane™ has a throughput of 668 MB/sec. Thus, the PCI I/O board throughput is 668/sec.

The I/O boards also offer improved environmental monitoring. The I/O boards have temperature sensors, allowing the actual temperature of individual boards to be monitored through Solstice SyMON.

SBus I/O Board

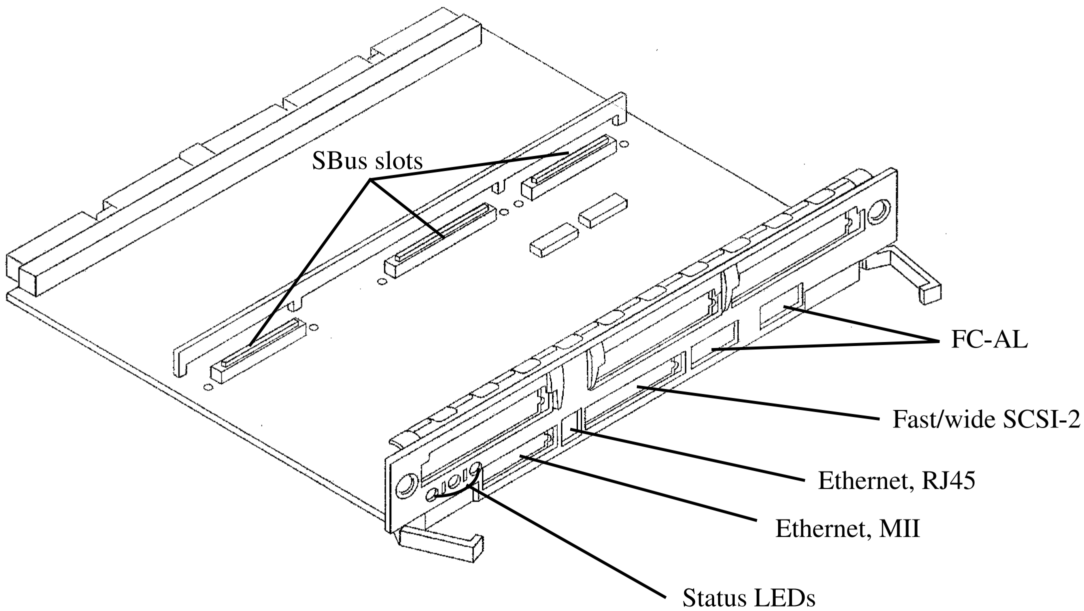


Figure 8. SBus I/O board

SBus I/O board features are:

- One on-board 10/100-Mb/sec. Ethernet port (twisted pair and MII connector)
- One 20-MB/sec., fast/wide SCSI-2 port
- Two empty 100MB/sec FC-AL sockets for GBIC modules in order to connect to StorEdge A5000's.
- Three 64-bit SBus slots running at 25 MHz
- Two 64-bit SBus channels, offering a peak throughput of 400 MB/sec.

Graphics I/O Board

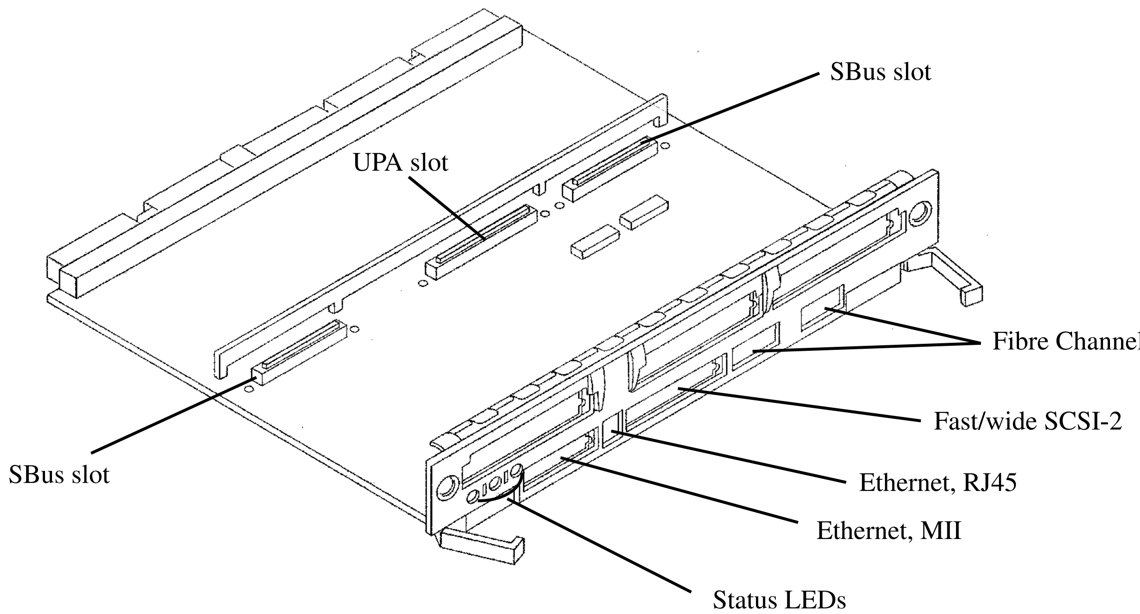


Figure 8. Graphics I/O board

The graphics I/O board, shown in Figure 8, includes the following features:

- One on-board 10/100-Mb/sec. Ethernet port (twisted pair and MII connector)
- One 20-MB/sec., fast/wide SCSI-2 port
- Two 25MB/sec Fibre Channel sockets for optical link modules to connect SPARCstorage Array subsystems
- Two 64-bit SBus slots running at 25 MHz
- One UPA slot for a Creator or Creator3D graphics board
- One 64-bit SBus channel, offering 200 MB/sec. data transfer

PCI I/O Board

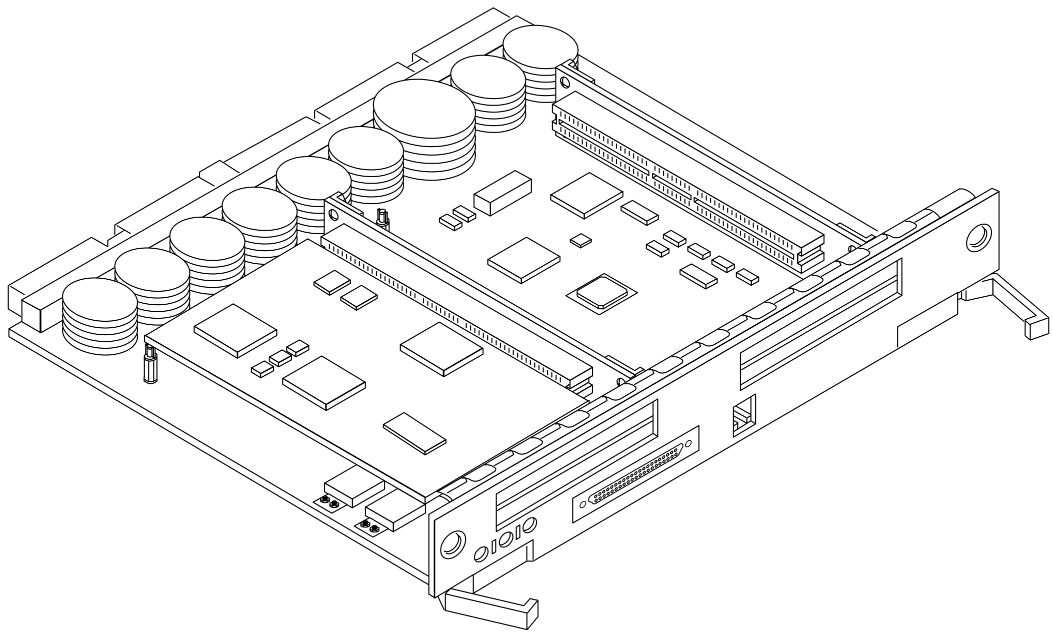


Figure 9. PCI I/O board

The PCI I/O board, shown in Figure 10, includes the following features:

- One on-board 10/100-Mb/sec. Ethernet port (twisted pair)
- One 20-MB/sec., fast/wide SCSI-2 port
- Two 64-bit PCI slots running at 66 MHz (also supports 33 MHz)
- Two 64-bit PCI channels, each offering 528 MB/sec. data transfer

I/O Board Connections

I/O boards connect to the Gigaplane bus. On the SBus I/O board, the UPA bus connects the Gigaplane bus to two SBus channels, which connect the various I/O ports to the UPA bus. On the graphics I/O board, the UPA bus connects the Gigaplane bus to one SBus channel and one UPA slot for a graphics card (Creator or Creator3D). On the PCI I/O board, the UPA interface connects the Gigaplane bus to two PCI-66 channels and two standard PCI channels. Figure 10 shows the logical block diagram of the SBus I/O board and graphics I/O board. Figure 11 shows the logical block diagram of the PCI I/O board.

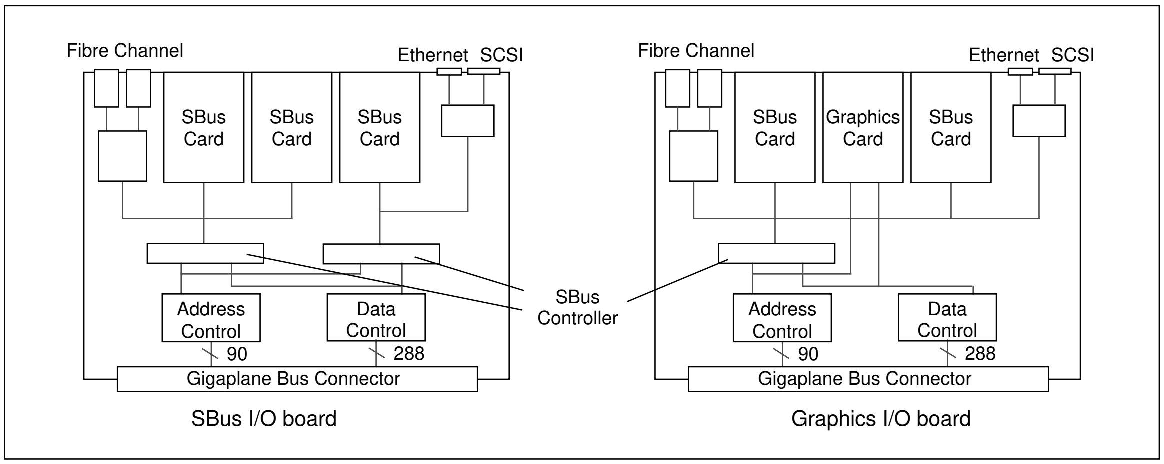


Figure 10. SBus I/O board and graphics I/O board block diagrams

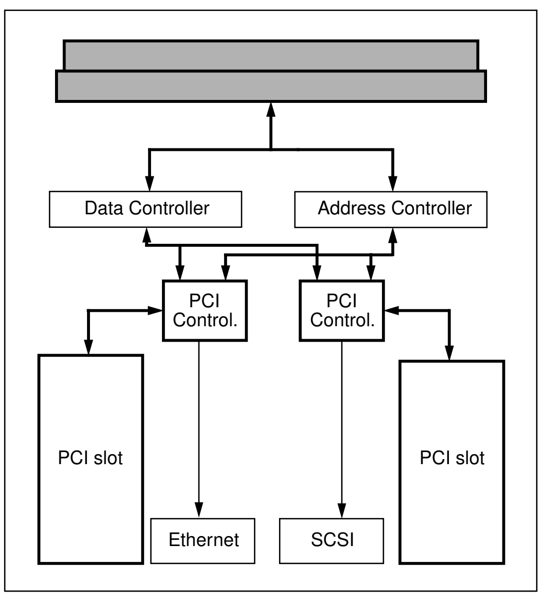


Figure 11. PCI I/O board block diagram

I/O Board Connections *(cont.)*

The tables below show which I/O devices are connected to each I/O channel.

Figure 12.

SBus I/O Board	
SBus channel 1	• 10/100-Mb/sec. Ethernet • 20-MB/sec. fast/wide SCSI • One SBus slot
SBus channel 2	• Two FC-AL sockets • Two SBus slots

Figure 13.

Graphics I/O Board	
SBus channel 1 UPA	• 10/100-Mb/sec. Ethernet • 20-MB/sec. fast/wide SCSI • Two SBus slots • Two Fibre Channel sockets • One UPA slot

Figure 14.

PCI I/O Board	
PCI-66 channel	• One PCI slot
PCI-66 channel	• One PCI slot
PCI channel	• 20-MB/sec. fast/wide SCSI
PCI channel	• 10/100-Mb/sec. Ethernet

Enterprise 3000–6000 servers can be PCI or SBus only systems. As of July 15, 1997, up to three PCI I/O boards are supported per Enterprise 3000 system and up to six PCI I/O boards are supported per Enterprise 4000–6000 system. Mixed PCI and SBus systems are also supported.

I/O boards are hot-pluggable. This means new I/O boards can be installed while the system is online, or I/O boards that have been de-configured from the system can be removed while the system is online. See "Reliability, Availability, and Serviceability" in the "Positioning" section for more details.

I/O Boards Q&A

Q. Will 32-bit SBus cards supported on the SPARCcenter 2000E and SPARCserver 1000E be supported in Enterprise 3000–6000 servers?

A. Yes.

Q. How many SPARCstorage Array subsystems can one I/O board support?

A. The maximum number of SPARCstorage Array subsystems that can be connected to an SBus I/O board is eight: two using the on-board Fibre Channel sockets, plus six using three dual-connect Fibre Channel SBus cards. For maximum performance, SPARCstorage Array connections should be evenly distributed between the dual SBus channels. The graphics I/O board can support up to six SPARCstorage Array subsystems.

Q. Does the graphics I/O board also support the TurboGX™ graphics card?

A. Yes. Both the graphics I/O board and the SBus I/O board support the TurboGX graphics card.

Q. Do dual-wide SBus cards work with the SBus I/O board or graphics I/O board?

A. One dual-wide SBus card will fit on an SBus I/O board. Only single-wide SBus cards will work with the graphics I/O board.

Q. What type of PCI cards can be used in the Enterprise 3000–6000 servers?

A. We support 3.3-volt or 5.0-volt PCI short cards (4.200 x 6.875 inches).

Q. Does Sun support (service) third-party PCI cards?

A. No. Sun does not support (service) third-party PCI cards. However, Sun has been working with third-party IHVs (Independent Hardware Vendors) to ensure a robust supply of cards for Sun™ platforms. PCI cards that have been verified by Sun to operate properly on Sun platforms have been subject to stringent testing. Http://www.sun.com/sunready/vendors.html to see a list of these PCI cards.

Q. What is included with the PCI I/O board?

A. The board comes pre-installed with two 5.0-volt riser cards. The PCI card plugs into the riser card. The PCI I/O board also comes with two 3.3-volt riser cards. If your PCI card is 3.3-volt, then you need to remove a 5.0-volt riser card and install a 3.3-volt riser card.

Q. Are there any software requirements for the PCI I/O board?

A. Yes. The PCI I/O board requires Solaris 2.5.1. Hardware: 4/97 or higher. The CPU/memory boards must also have at least OpenBoot™ PROM (OBP) version 3.2.8 or later.

Q. Do PCI cards on the same PCI I/O board have to be the same voltage?

A. No. You may have one 5.0-volt card and one 3.3-volt card on the same PCI I/O board. Just be sure that you are using the appropriate riser card for each PCI card.

Power and Cooling

Enterprise 3000–6000 servers offer a highly flexible, highly reliable power and cooling environment. With an N+1 system configuration (where N is the minimum number of power supplies required), Enterprise 3000–6000 servers offer redundant power, using power/cooling modules that are hot swappable. This offers customers a system that will almost never fail due to a power supply or a fan failure.

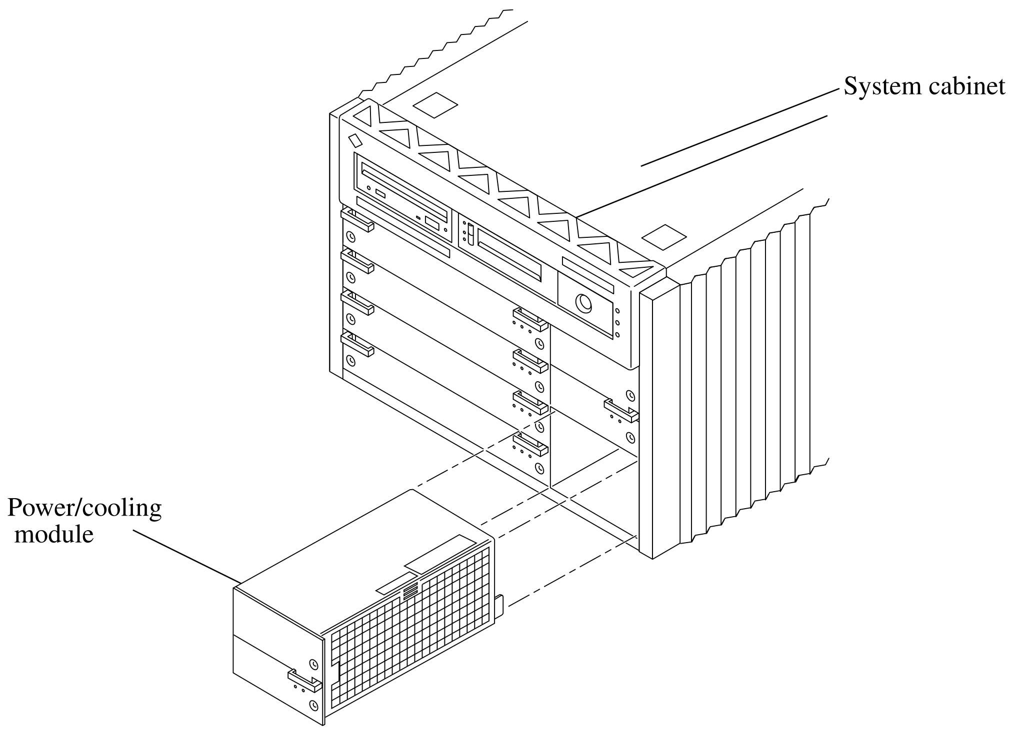


Figure 15. Enterprise 4000 server hot-swappable power/cooling module

Power Circuitry

There are two different types of power supplies in Enterprise 3000–6000 servers: power/cooling modules (PCMs) and peripheral power supplies (PPSs).

- PCMs contain a power supply and two variable-speed fans. The number of power/cooling modules installed in a system depends on the system configuration.
- One PCM is required for every two adjacent boards on each side of the centerplane.
- The Enterprise 3000 server supports a maximum of three power/cooling modules.
- The Enterprise 4000 and 5000 servers support a maximum of four power/cooling modules.
- The Enterprise 6000 server supports a maximum of eight power/cooling modules.
- Power from the PCMs is distributed throughout the system using current-sharing circuitry, so that if the power supply in one PCM fails, power from the other PCMs keeps the system running (if the system is configured for redundant power).
- To configure a system *without* redundant power, the system must have $x/2$ PCMs, where x is the number of CPU/memory, I/O and disk boards (round up to the nearest whole number).
- To configure a system *with* redundant power, the system must have ($x/2 + 1$) PCMs, where x is the number of CPU/memory, I/O and disk boards (round up to the nearest whole number).
- When configuring the Enterprise 4000 server, there is one exception to the redundant configuration rule. An Enterprise 4000 server with eight boards is able to run on three power supplies, so only four power supplies are required for redundancy. The peripheral power supply is connected to the same power circuitry as the PCMs, providing the additional power required for redundancy.
- When configuring the Enterprise 6000 server, there are two exceptions to the redundant configuration rule. Following the $x/2+1$ configuration rule an Enterprise 6000 system with 16 boards would require nine PCMs ($16/2 + 1 = 9$). But there are only eight PCM slots. In order to resolve this issue, each PCM is able to supply slightly more power than is required, so an Enterprise 6000 with 16 boards can operate on seven PCMs. Similarly, the Enterprise 5000 system requires only three PCMs to operate. Four PCMs are required for redundant power.
- The PCM is hot-swappable. Therefore, if a power supply fails, the PCM can be replaced (assuming the system is configured for power/cooling redundancy) while the system is running without any adverse effects to the system.
- Enterprise 3000–6000 servers have one peripheral power supply (PPS). The PPS provides power for the internal SCSI devices as well as additional power for the system boards. If a PPS fails, the system continues to run, but the internal SCSI devices are not functional until the PPS is replaced. The PPS is hot-pluggable but not redundant.
- The dual power supplies in the cabinet fan tray offer redundant power for the fans in the Enterprise 5000 and 6000 system cabinets and the expansion cabinet. The cabinet fan tray has four fans and two power supplies. If one power supply fails, two fans stop working. The remaining two fans are able to keep the cabinet cool. The power supplies in the cabinet fan tray are not hot-pluggable.

System Cooling

Enterprise 3000–6000 servers have multiple PCMs for cooling the CPU/memory, I/O, and disk boards (Enterprise 4000–6000 only), and one set of dual fans to cool the AC distribution assembly, clock board, and peripherals.

- The PCMs include a power supply and two variable-speed fans.
- With dual, variable-speed fans, if one fan fails, the other fan speeds up to increase its cooling capacity.
- The PCM is hot-pluggable. Therefore, if a fan fails, the PCM can be replaced (assuming the system is configured for power/cooling redundancy) while the system is running without any adverse effects to the system.
- The fans within a PCM are powered by all the power supplies in the system through current sharing. With this design, if a power supply fails, the fans within that PCM continue to run.
- Variable-speed fans minimize system noise.
- The Enterprise 5000 and 6000 system cabinet includes one cabinet fan tray. The cabinet fan tray includes four fans supported by two power supplies. Each power supply supports two fans. The cabinet fan tray in the system cabinet directs the hot air from the card cage and peripheral devices out the rear of the cabinet.
- Each Enterprise expansion cabinet also contains one cabinet fan tray. The cabinet fan tray in an expansion cabinet can be connected to the system cabinet so that Solstice SyMON is able to detect the failure of a cabinet fan tray in an expansion cabinet. The cabinet fan tray is not hot-pluggable.

Power and Cooling Q&A

Q. If a fully configured eight-board Enterprise 4000 server can operate on three power/cooling modules, can an identically configured eight-board Enterprise 6000 server also operate with three power/cooling modules?

A. No. In the Enterprise 4000 server, the peripheral power supply and the power/cooling modules are connected to the same power circuit. Therefore, if one power/cooling module fails, power from the other three power/cooling modules plus power from the peripheral power supply provide enough power to run the system. This allows eight boards to be powered by three power/cooling modules.

However, in the Enterprise 6000 server, the peripheral power supply and power/cooling modules have different power circuits. Therefore, if one power/cooling module fails, the only power available is from the three remaining power/cooling modules, which is not enough to support the system.