



Sun Fire™ X4600/X4600 M2 Server Architecture

A Technical White Paper

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Introduction

As the first of its kind, the Sun Fire X4600 server is the fastest, most scalable, and energy-efficient four-way to 16-way x64 (x86 64-bit) server. It scales quickly from two sockets to eight sockets simply by adding processor boards, all in a compact 4RU form factor. The new modular processor board for the Sun Fire X4600 M2 server allows up to ¼ terabyte of memory in a fully configured system. With its multiple operating system support, extensive ISV application offerings, time-saving manageability, and availability features, the Sun Fire X4600 server is the top midrange solution for server consolidation and virtualization, enterprise applications, and High Performance Computing (HPC).

Sun Fire x4000 Server Family Overview

The Sun Fire x64 server line is composed of the industry's premier x64 servers. The Sun Fire x64 server line delivers the highest reliability and greater than one-and-a-half times the performance of comparable Intel Xeon-based servers, while providing significant savings in power and cooling costs. These Sun servers are based on a simplified management system and fast and reliable performance, resulting in better service levels, lower operational costs, and better asset utilization.

The Sun Fire x64 family of servers features x64 performance with 32-bit x86 compatibility, large memory support, I/O capability to support low-latency, high-bandwidth interconnects for compute clusters, Integrated Lights Out Management with in-band and out-of-band control, and a wide range of peripheral and ISV support. This is the only family of x64 industry-standard servers with application portability across the entire family through binary compatibility on Solaris™, Linux, or Windows operating systems.

The Sun Fire x64 server family also includes an extensive set of RAS (Reliability, Availability, and Serviceability) features that reduce hidden serviceability costs by dramatically simplifying system maintenance. In addition, the Sun Fire x64 family of servers provides remote lights out server management, including remote keyboard, video, mouse, and storage (RKVMS); remote boot; and remote software upgrades using the Integrated Lights Out Manager (ILOM) Service Processor.



Figure Intro-1: Sun Fire X4000 Server Family

Customers seeking a business edge can look to Sun to provide smart options for building a simple, secure, and standardized IT infrastructure. The Sun Fire x64 family of servers enables standardization of the datacenter by providing the unity of vertical scaling with the economies of horizontal scaling, while running any major OS and 32-bit/64-bit application. Sun continues its efforts to provide customers with solutions to help them realize the benefits of a horizontal infrastructure (lower incremental CPU cost and OS flexibility) while reducing hidden costs and complexities.

Sun Fire X4600 Overview

The Sun Fire X4600 is the third member of the Sun Fire X4000 server family. Like its two predecessors, the Sun Fire X4100 and X4200 servers, the Sun Fire X4600 is designed to improve the economics of x64 systems while setting new standards for performance, reliability, and energy efficiency. The Sun Fire X4600 is a high-performance, single- or dual-core platform scalable up to 8 sockets in a 4RU package. The 8 sockets will scale to 16 processor cores and up to ¼ terabyte of memory. It features redundant, hot-swappable fan modules and redundant, hot-pluggable AC power supplies to enable increased availability and simplified serviceability. It supports an I/O feature set that includes four 10/100/1000 BaseT Gigabit Ethernet ports, a four-channel SAS RAID 0/1 disk controller with integrated mirroring, video, USB ports (two front, two rear), and a dedicated serial and 10/100BaseT Ethernet remote management port. For further expansion, the Sun Fire X4600 provides two low-profile PCI-X slots and six low-profile PCI-E slots for high-performance application I/O. Up to eight single- and dual-core AMD Opteron CPUs provide a flexible, high-performance growth path and investment protection (32-bit applications are protected while still enabling seamless migration to 64-bit applications).



Figure Intro-2: The Sun Fire X4600 Server

The highly scalable 4- to 16-way Sun Fire X4600 server allows customers to dramatically improve business agility and growth without any data center disruption and no change to the operating system, software, rack, network infrastructure, or storage connections. The Sun Fire X4600 server can be used to build 5-teraflop (or larger) systems.

Table Intro-1 shows how the new Sun Fire X4600 server compares to the Sun Fire X4100 and X4200 servers. Shaded cells indicate differences.

Table Intro-1: Sun Fire X4100, X4200 and X4600 Servers Features Comparison

Features	Sun Fire X4100/X4200	Sun Fire X4600 M2
Form Factor	1/2 RU	4 RU
Processor	Up to two AMD Opteron 800 Series Single- or Dual-Core CPUs w/ 1 MB L2 Cache per Core	Up to eight AMD Opteron 8000 Series Dual-Core only CPUs w/ 1MB L2 Cache per Core
BIOS	AMI BIOS8 (Different revision)	AMI BIOS8 (Different revision)
Memory DIMM Slots	4 DIMM slots per CPU	4 or 8 DIMM slots per CPU
Memory Type	PC3200 400MHz Registered DIMMs with ECC	PC6300 667 Mhz Registered DIMMs with ECC
Memory Module Sizes	1 GB, and 2 GB DIMMs	1 GB, 2 GB , 4 GB DIMMs
Maximum Memory	64 GB w/2 GB DIMMs	256 GB w/4 GB DIMMs
HDD Controller	LSI SAS1064 Serial Attached SCSI (SAS)	
HDD Type	2.5-inch drives (SAS)	

Features	Sun Fire X4100/X4200	Sun Fire X4600 M2
HDD Number	Four HDDs	
Optical Drive	CD/DVD-ROM	
NIC Controller	Dual Intel FW82546GB	
NICs	Quad Gigabit Ethernet ports	
Graphics Controller	ATI Rage XL	
Expansion Slots	Six PCI-E Low Profile and Two PCI-X MD2	
Front I/O	Two USB 2.0 ports (Type A)	
Rear I/O	Four Gigabit Ethernet ports (RJ45) One 100BaseT Management port (RJ45) One RS-232 Serial (RJ45) Two USB 2.0 ports (Type A) VGA Video port (DB15)	
Power Supply	Redundant Hot Swappable 4 x 850W	
System Management	Service Processor board supporting Graphics redirection, Remote Floppy/CD, IPMI 2.0, SNMP, CLI and Web interface	
OS Support	Solaris, Linux, Windows, and VMware	

Sun Fire X4600 Target Markets and Applications

The Sun Fire X4600 server provides mission-critical enterprise data center solutions across all industries. It is particularly well-suited for the following applications:

- Collaboration
 - Email
 - Document management
- Server consolidation
- Data collection and analysis
 - ERP
 - CRM
 - Data warehousing
 - Databases
- Product development and delivery
 - Simulation
- Transaction processing
 - Billing
 - Customer service
 - Application server
- High Performance Computing (HPC)

Chapter 1 Architecture Overview

Sun Fire X4600 Server

The Sun Fire X4600 server measures 4 rack-units (6.9 inches/176 mm) high, 17.5 inches (445 mm) wide, and 24.75 inches (629 mm) deep. It is a 4- to 16-way rack-optimized, x64-based system with a symmetric multiprocessor. Cooling is accomplished with internal fans that direct airflow from the front to the back of the chassis. I/O ports are located on the rear panel, with additional USB on the front panel. Access to the power connections is at the rear of the server. Hard drives and optical storage are accessible from the front of the server.

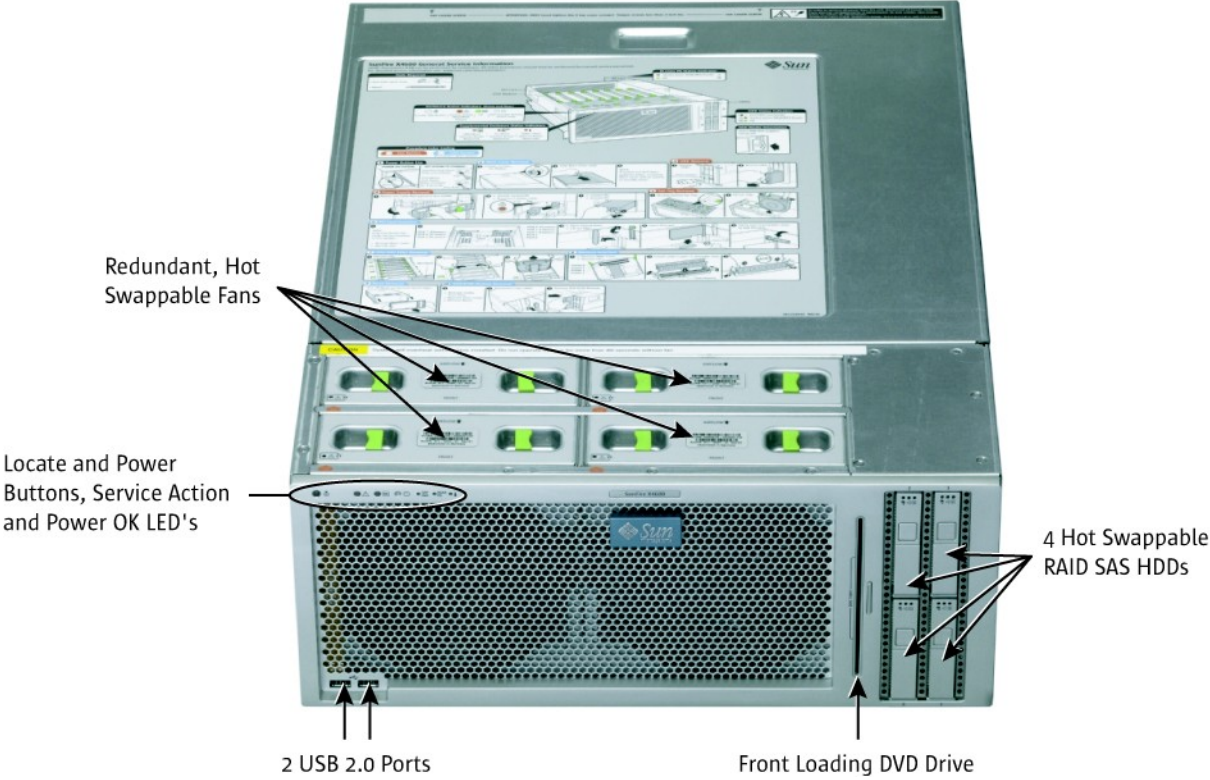


Figure 1-1: Front View of the Sun Fire X4600

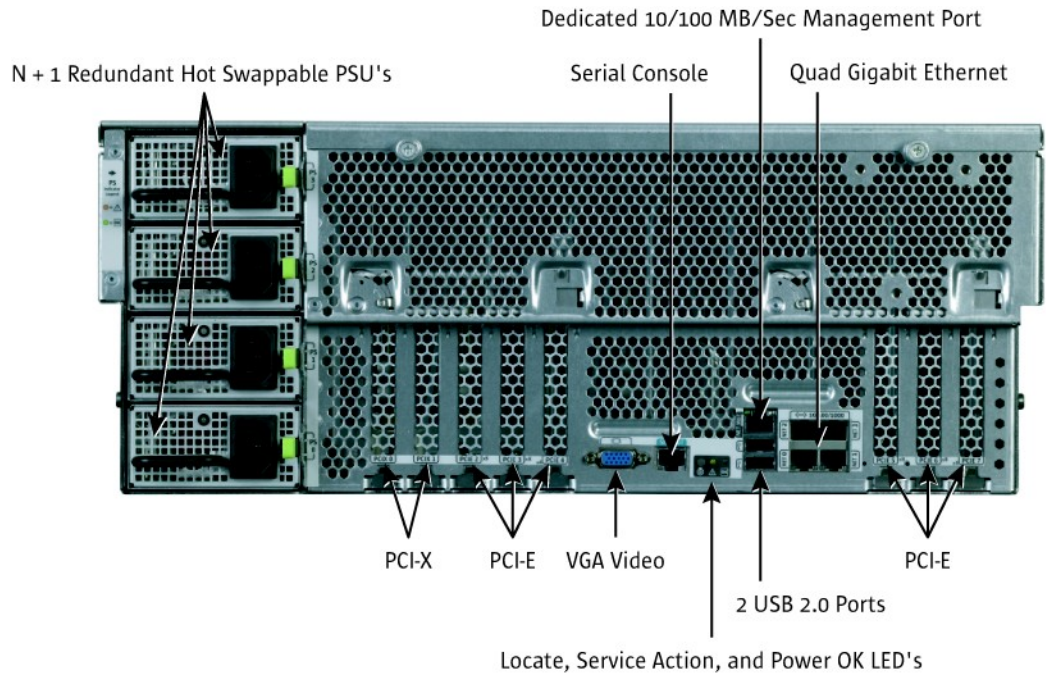


Figure 1-2: Rear View of the Sun Fire X4600 Server

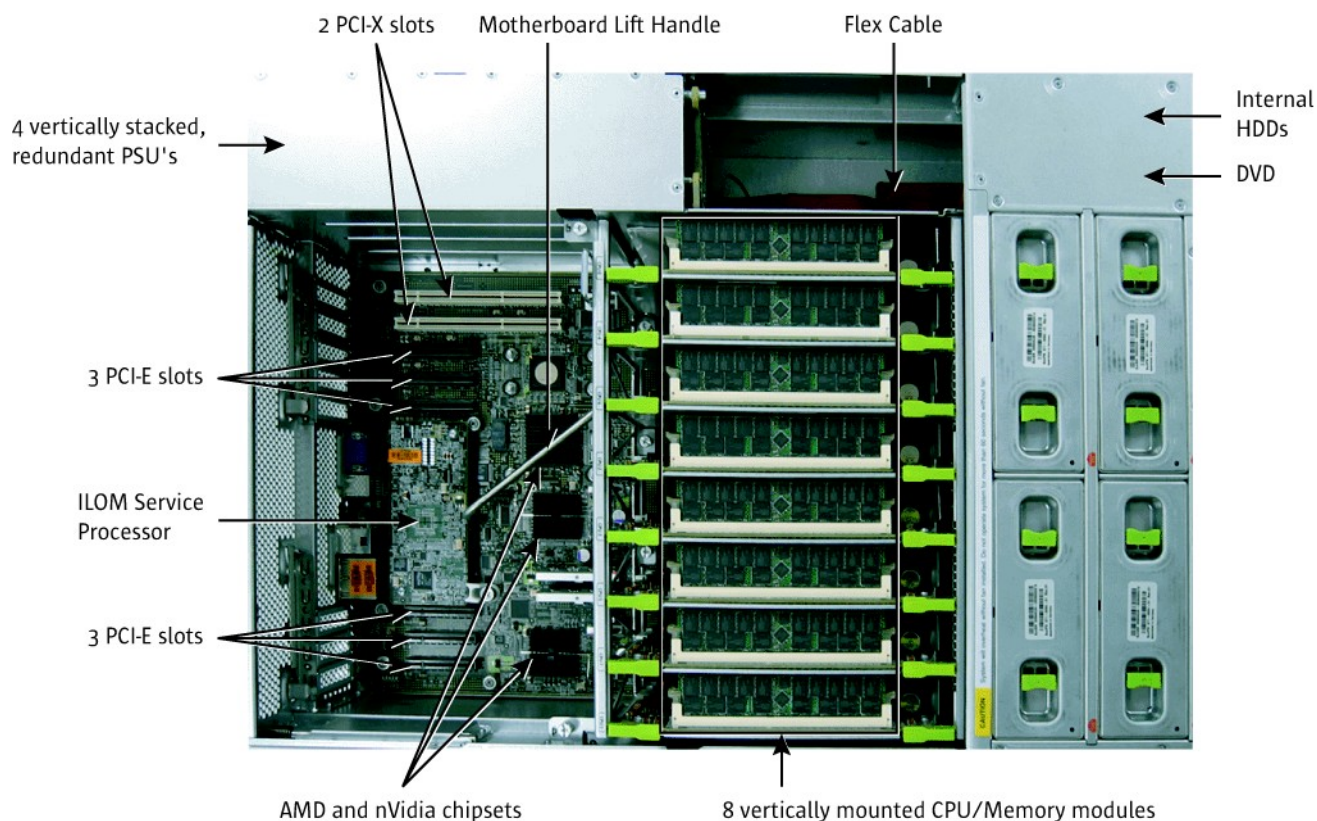


Figure 1-3: Internal View of the Sun Fire X4600 Server

The Sun Fire X4600/X4600 M2 server also provides the following system architecture features:

- Sun Fire X4600: Embedded dual-channel DDR1 memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling and deliver up to 64 GB of capacity and 51.2 GB/sec. of aggregated bandwidth with eight populated CPUs and 2 GB DIMMs.
- Sun Fire X4600 M2: Embedded dual-channel DDR2 memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling and deliver up to 256 GB of capacity and up to 85.6 GB/sec. of aggregated bandwidth with eight populated CPUs and 4 GB DIMMs.
- AMD Direct Connect Architecture that directly connects CPU-to-CPU with Coherent HyperTransport™ links to deliver 8 GB/sec. aggregate bandwidth per link, CPU-to-I/O with non-Coherent HyperTransport links to deliver 8 GB/sec. aggregate bandwidth per link, CPU-to-memory using the integrated DDR controller, and CPU cores to each other on the same die in dual-core processors
- Two PCI-X and six PCI-E slots to deliver high-performance I/O with over 160 GB/sec. of I/O plug-in bandwidth
- Embedded quad Gigabit Ethernet and a SAS disk controller to leave the two PCI available for expansion needs

- Embedded management and legacy I/O to offer maximum operational flexibility without compromising PCI slots for optional features

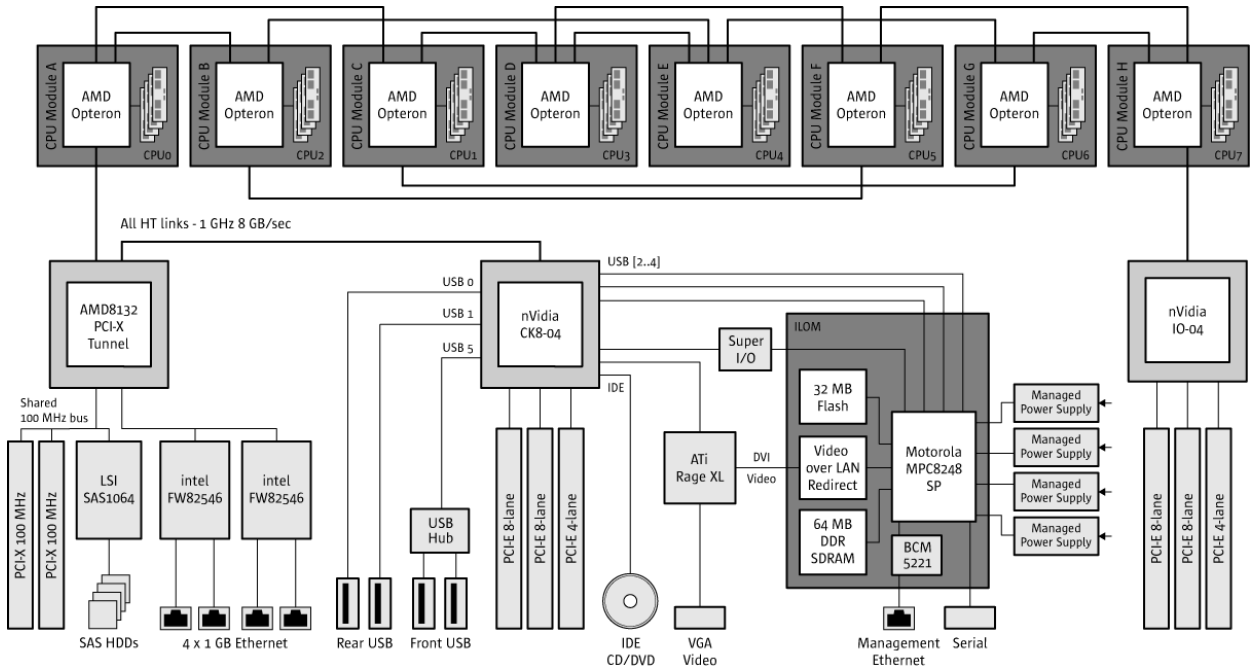


Figure 1-4: Sun Fire X4600 Server Architecture Block Diagram with Eight CPUs

Chapter 2

CPU Architecture

The Sun Fire X4600 server supports up to eight Single-Core or Dual-Core AMD Opteron Series 800 processors. Each CPU module has an attached PCB containing:

- 1 AMD Opteron CPU and heatsink
- 4 DDR1 memory DIMM slots
- 1 CPU/RAM VRM
- Airflow redirection baffles for greatest cooling efficiency

The Sun Fire X4600 M2 server supports up to eight AMD Opteron Series 8000 (Dual-Core and Multi-Core in the future) processors. Each CPU module has an attached PCB containing:

- 1 AMD Opteron CPU and heatsink
- 8 DDR2 memory DIMM slots
- 1 CPU/RAM VRM
- Airflow redirection baffles for greatest cooling efficiency

The CPU module is connected to the system motherboard using a pair of ganged connectors.

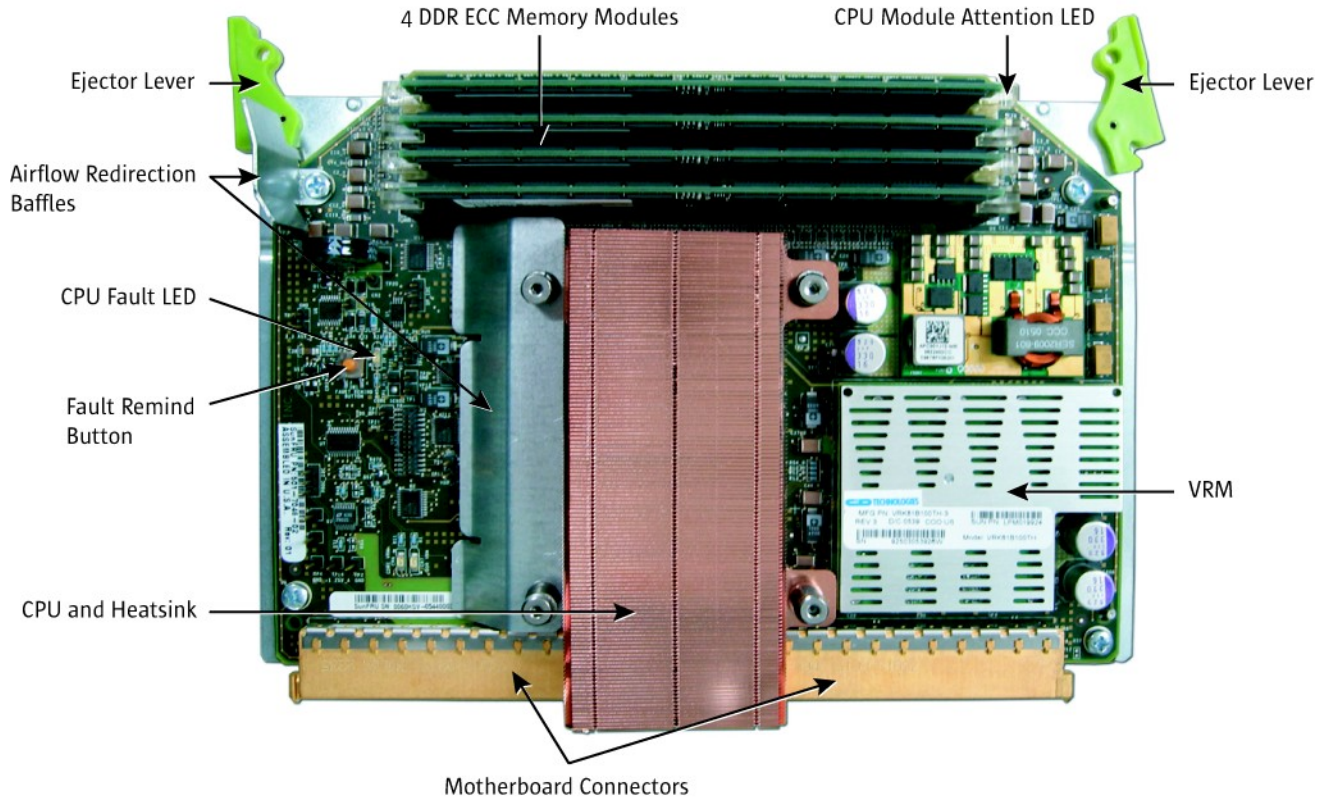


Figure 2-1: Sun Fire X4600 CPU Module

Systems configured with four or six processors require filler modules. The filler modules maintain the HyperTransport connectivity between all CPUs and provide airflow redirection for efficient cooling throughout the system. Figure 2-2 illustrates the placement of CPU and filler modules, physical slot numbering, and the CPU enumeration from the BIOS perspective.

Front of Server								
	Slot A	Slot B	Slot C	Slot D	Slot E	Slot F	Slot G	Slot H
8 Processors	Module 0	Module 2	Module 1	Module 3	Module 4	Module 5	Module 6	Module 7
6 Processors	Module 0	Module 1	Filler	Module 2	Module 3	Module 4	Filler	Module 5
4 Processors	Module 0	Filler	Filler	Module 1	Module 2	Filler	Filler	Module 3
2 Processors	Module 0	Module 1	EMPTY	EMPTY	EMPTY	EMPTY	EMPTY	EMPTY

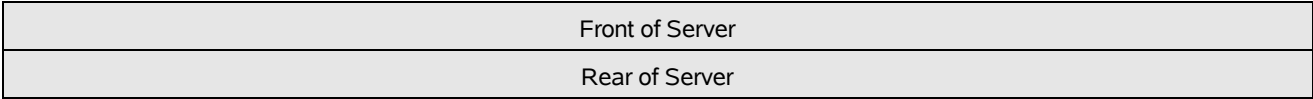


Figure 2-2: CPU Module Placement

Note: The Sun Fire X4600 server supports four and eight CPU configurations. Two, four, six, and eight CPU configurations are supported in the Sun Fire X4600 M2.

In Sun Fire X4600 systems, each processor contains an integrated memory controller that supports a 128-bit-wide path to memory and three 16x16-bit HyperTransport links. Each HyperTransport link runs at speeds up to 1 GHz and is clocked on both edges of the clock pulse, which allows for a maximum of 4 GB/sec. (2 gigatransfers/sec., 2 bytes wide) throughput in each direction (8 GB/sec. aggregate data rate bi-directionally). Memory support is for registered DDR400 184-pin SDRAM DIMMs. There are four DIMM slots per CPU. DIMMs are accessed in pairs with an available memory bandwidth up to 6.4 GB/sec. (with PC3200) per processor.



Figure 2-3: 8-DIMM Processor Board

In Sun Fire X4600 M2 systems, each processor contains an integrated memory controller that supports a 128-bit-wide path to memory and three 16x16-bit HyperTransport links. Each HyperTransport link runs at speeds up to 1 GHz and is clocked on both edges of the clock pulse, which allows for a maximum of 4 GB/sec. (2 gigatransfers/sec., 2 bytes wide) throughput in each direction (8 GB/sec. aggregate data rate bi-directionally). Memory support is for registered DDR2/667 240-pin SDRAM DIMMs. There are four or eight DIMM slots per CPU. DIMMs are accessed in pairs with an available memory bandwidth up to 10.7 GB/sec. (with PC6300) per processor.

Memory capacity scales with the number of processors, so memory attached to an unpopulated processor socket is unaddressable. As a result, a single processor machine can support a maximum of four DIMMs, while a fully-populated, eight-CPU server can support a maximum of 32 or 64 DIMMs (X4600 or X4600 M2) with up to 256 GB (64 x 4GB) of memory.

The AMD processor does support up to eight DIMMs per CPU. However, using more than four DIMMs requires clocking down DIMM speed to 533 MHz, even if the DIMMs used are of the highest speed bin.

AMD Opteron Processor

Features of the AMD Opteron processor in the Sun Fire X4600 and Sun Fire X4600 M2 servers include:

- Up to eight Single-Core or Dual-Core AMD Opteron 800 Series processors (Sun Fire X4600).
- Up to eight Dual-Core AMD Opteron 8000 Series processors (Sun Fire X4600 M2).
- x64 architecture (64-bit extensions) with AMD Direct Connect Architecture using HyperTransport Technology.
- PowerNow! support to dynamically adjust performance based on CPU utilization (voltage and frequency are adjusted depending on kernel load). By default, PowerNow! is disabled in BIOS.
- Native support for 32-bit x86 ISA, SSE, SSE2, MMX, and 3DNow!
- Three HyperTransport links supporting up to 8 GB/sec. of direct inter-processor and I/O bandwidth per link.
- ECC protection for L1 data cache, L2 unified cache, and DRAM with hardware scrubbing of all ECC protected arrays.
- CPU L1 Instruction cache: 64 KB two-way associative, parity protected with advanced branch prediction.
- CPU L1 Data cache: 64 KB two-way associative, ECC protected.
- Two 64-bit operations per cycle, three-cycle latency.
- CPU L2 cache: 1 MB 16-way associative, ECC protected.
- Exclusive cache architecture storage, in addition to L1 caches.
- 256 TB of memory address space.

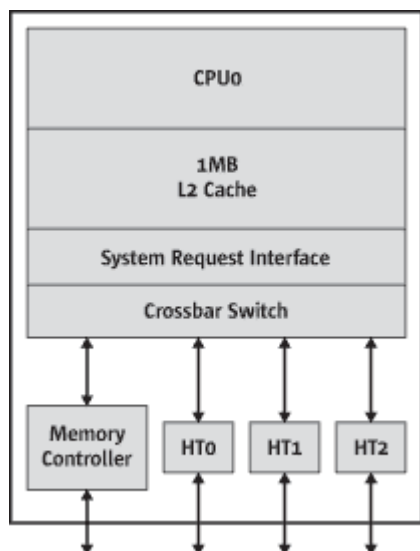


Figure 2-4: Single-Core AMD Opteron Processor Architecture

The Sun Fire X4600 server supports both Single-Core and Dual-Core AMD Opteron 800 Series processors. The Sun Fire X4600 M2 server supports Dual-Core AMD Opteron 8000 Series processors. From the start, AMD64 processors were designed to add a second core—the port already existed on the crossbar/SRI. Dual-core AMD Opteron processors have unique instances of L1 cache (I-cache and D-cache) and L2 cache for each CPU core. Features of the Dual-Core AMD Opteron processor include:

- Socket compatibility with existing 940-pin sockets that are compatible with 90nm single-core processor architectures
- One die with two CPU cores
- The same power requirements as single-core CPUs
- Individual L1 Instruction cache per CPU core
- Individual L1 Data cache per CPU core
- Individual 1-MB L2 cache per CPU core
- Shared memory controller and HyperTransport interconnects for two cores
- Fully utilized memory and HyperTransport bandwidths

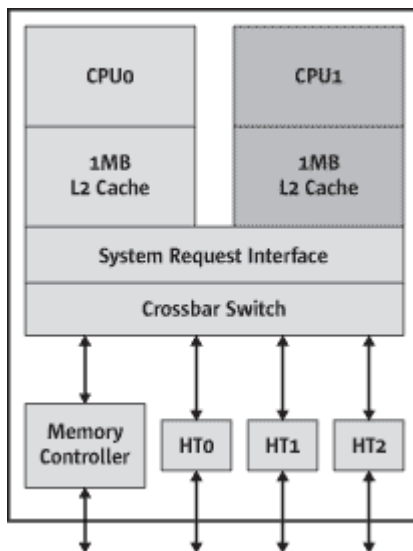


Figure 2-5: Dual-Core AMD Opteron Processor Architecture

Note: Sun Fire X4600 servers support 95 W and 120 W 90 nm technology package infrastructure AMD Opteron Rev E and Rev F processors only.

CPU Packaging

AMD Opteron 800 series processor packaging specifications include:

- 940-pin lidded organic micro PGA
- 1.27 mm pin pitch
- 31 x 31 row pin array
- 40 mm x 40 mm organic substrate
- Organic C4 die attachment
- 16.5 mm x 11.3 mm die size

AMD Opteron 8000 series processor packaging specifications include:

- 1207-pin organic land Grid Array (OLGA)
- 1.1 mm pin pitch
- 35 x 35 row pin array
- 40 mm x 40 mm organic substrate
- Organic C4 die attachment
- 16.5 mm x 11.3 mm die size

Processor VRM

Each processor receives core voltage input from an individual voltage regulator module (VRM). The VRMs regulate the system current and voltage according to the VID code output by the CPU package. The VRM is a DC-to-DC point-of-load convertor specified for +12 Volt input and programmable 100 Amp output. The VRM is different on the new 8-DIMM Processor Boards to accommodate the additional memory requirements.

Memory Architecture

Each CPU includes a low-latency, high-bandwidth, integrated memory controller that reduces latencies during memory access over traditional Intel front-side bus-based memory controllers, and each supports up to four ECC Registered DDR400 (Sun Fire X4600) or up to eight ECC Registered DDR2/667 (Sun Fire X4600 M2) memory modules. Although the AMD Opteron processor's memory controller works in 64-bit or 128-bit mode ECC operation, for best performance results, it is recommended to run 128-bit ECC operation mode. To run in 128-bit mode, DIMMs should be populated in pairs such that they occupy one-half of the AMD Opteron processor's 128-bit controller interface. The controller supports 1 bit per byte ECC and supports DDR400 (PC3200) registered DDR SDRAM modules. The Sun Fire X4600 uses DDR400 (PC3200) registered DDR SDRAM modules and the Sun Fire X4600 M2 uses DDR2/667 (PC2-5300) registered DDR SDRAM modules

The Sun Fire X4600 server has 4 DDR DIMM slots per CPU that are color-coded white and black to indicate population order (white = 0,1 and black = 2,3; white pair first). LED fault indicators controlled by the ILOM Service Processor provide the ability to easily identify failed DIMM modules. Memory capacity scales with the number of processors, so memory attached to an unpopulated processor slot is unaddressable. As a result, a dual-socket machine can support a maximum of eight DIMMs. A fully populated, eight-CPU server supports a maximum of 32 DIMMS or 128 GB of memory.

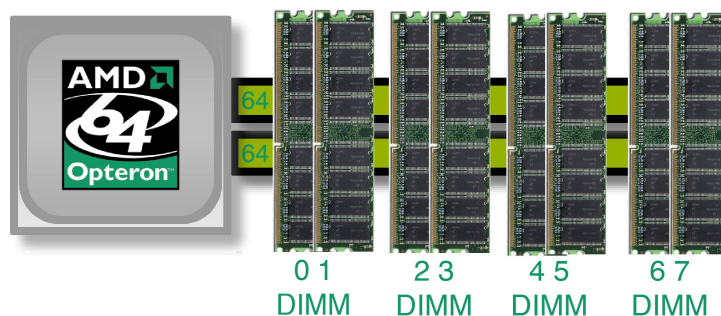


Figure 2-6: Logical View of Sun Fire X4600 8-DIMM Memory

The Sun Fire X4600 M2 server has a new processor board that supports 8 DDR DIMM slots per CPU that are color-coded white and black to indicate population order (black = 0,1, 2, 3 and white = 4, 5, 6, 7). Memory is

populated in pairs in memory slots from the top of the board toward the processor heat sink at bottom of the board. Memory slots should be populated with D7 and D6 first, then D5 and D4, then D3 and D2, and finally D1 and D0 next to the processor heat sink. LED fault indicators controlled by the ILOM Service Processor provide the ability to easily identify failed DIMM modules. Memory capacity scales with the number of processors, so memory attached to an unpopulated processor slot is unaddressable. As a result, a dual-socket machine can support a maximum of sixteen DIMMs.

A fully populated, eight-CPU server supports a maximum of 64 DIMMs or 256 GB of memory. With just two or four DIMMs populated, the system runs memory at 667 MHz. With 6 or 8 DIMMs populated, the system runs memory at 533 MHz. The white group (D7-D4) of 4 DIMMs must have the same size DIMMs (1GB, 2GB, or 4GB). The black (D3-D0) group of DIMM slots must have the same size DIMMs but can be a different size DIMMs than the white group of DIMMs.

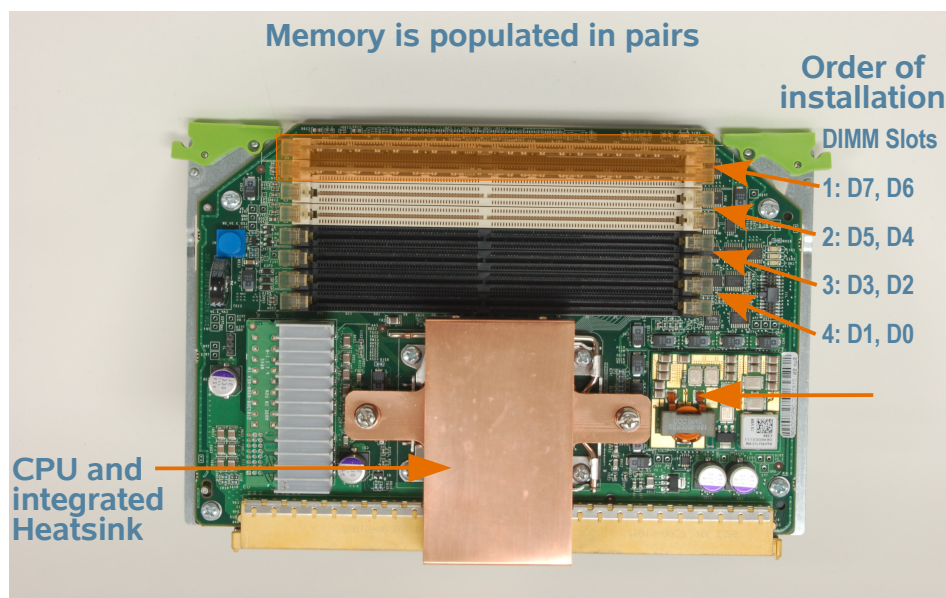


Figure 2-7: 8 DIMM Processor Board with Memory Installation Order

Other features of the Sun Fire X4600 and Sun Fire X4600 M2 servers memory architecture include:

- Dedicated on-die 128-bit wide DDR memory controller
- Memory bandwidth up to 6.4 GB/sec. @ DDR400 (Sun Fire X4600)
- Memory bandwidth up to 10.7 GB/sec. @ DDR2/667 (Sun Fire X4600 M2)
- Under 80 ns latency
- Registered ECC DDR400 (PC3200) supported (Sun Fire X4600)
- Registered ECC DDR2/667 (PC2-5300) supported (Sun Fire X4600 M2)

- 512 MB to 2 GB low profile (1.2 inch/3.05 cm) DIMM support
- Up to 32 GB per CPU in with 4 GB DIMMs in 8 DIMM slots per CPU
- Single supply (2.50 VDC)
- Standard SPD (VCC-SPD=3.3V)

x64 Architecture

The x64 architecture is an x86-compatible architecture that enables simultaneous 32- and 64-bit computing. It enables end users to run their existing installed base of 32-bit applications and operating systems at peak performance, while providing a migration path that is 64-bit capable. It is designed to enable 64-bit computing while remaining compatible with the vast x86 software infrastructure. x64 architecture represents a new class of computing, enabling a single architecture across 32- and 64-bit environments.

The x64 Instruction Set Architecture (ISA) extends the existing x86 ISA and natively executes 32-bit code with no emulation mode to degrade performance. For 32-bit software that does not require immediate 64-bit implementations, x64 processor-based systems are designed to provide full application performance while continuing to improve with x64 platform performance enhancements.

Many applications encounter architectural barriers that prevent efficient performance scaling. The x64 ISA is designed to allow continued performance scaling for applications that demand multiprocessor scalability, larger addressable memory, better multimedia performance, or improvements in computational accuracy.

The x64 ISA has been designed for applications that:

- Need large memory addressing to handle data sets larger than 3 GB per process (financial and scientific modeling applications)
- Must manage a large number of concurrent users or application threads, such as large-scale, thin-client solutions, large databases, data warehouse applications for solutions in customer relationship management (CRM), supply chain management (SCM), enterprise resource planning (ERP), and digital rights management (DRM) systems
- Require real-time encryption and decryption for enhanced security, including e-commerce and protection of private or classified data
- Require mathematical precision and floating-point performance, including modeling, simulation, statistics and financial analysis, imaging/video/signal processing, physics, medical research, telecommunications, encryption, and compression
- Require large, high-power database performance, including decision support, searching and indexing, document and content management, and voice recognition
- Require x86 compatibility or the economies of scale of x86 as well as the large memory addressing capabilities of 64-bit computing, including many high-performance computing (HPC) cluster applications

- Provide digital content creation capabilities such as computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE), digital music production and video editing, and real-time media streaming solutions
- Require maximum performance for realistic and cinematic consumer experiences, including computer games, digital video, and real-time collaboration

x64 processors are designed to maintain full compatibility with x86 while providing the architectural enhancements that provide world-class 64-bit performance. With the x64 ISA, relevant instructions and encodings have evolved to support 64-bits, increasing the resources available to hardware and software. Major enhancements over legacy x86 include:

- Sixteen 64-bit general-purpose integer registers that quadruple the general purpose register space available to applications and device drivers as compared to x86 systems
- Sixteen 128-bit XMM registers for enhanced multimedia performance to double the register space of any current SSE/SSE2 implementation
- Full 64-bit virtual address space with 40 bits of physical memory addressing that can support systems with up to 4 petabytes of physical memory—65535 times the amount of RAM supported by 32-bit x86 systems
- 64-bit operating systems to provide full, transparent, and simultaneous 32-bit and 64-bit platform application multitasking

x64 processors include HyperTransport Technology and are designed for flexibility and scalability. HyperTransport Technology provides links-based multiprocessing, simplifying the design of multiprocessor workstations and servers. Compatibility with x86 makes the x64 computing platform the first 64-bit platform designed to be compatible with mainstream PC applications while offering world-class performance, making it suitable for solutions ranging from consumer client PCs to high-performance clusters. The combination of flexibility and scalability reconciles the broad range of capability and performance requirements IT professionals face today.

AMD Direct Connect Architecture

AMD Direct Connect Architecture helps eliminate the bottlenecks inherent in a front-side bus by directly connecting the processors, the memory controller, and the I/O to the CPU to enable overall system performance and efficiency. Directly connected CPUs provide more linear, symmetrical multiprocessing. A memory controller directly connected to a CPU optimizes memory performance, while an I/O directly connected to a CPU provides more balanced throughput and performance. Dual-core processors extend the benefits of the AMD Direct Connect Architecture by connecting two CPU cores to each other on one die to reduce latencies between those cores.

HyperTransport™ Technology

HyperTransport™ Technology is a high-speed, high-performance, point-to-point link for directly connecting integrated circuits. HyperTransport Technology also directly connects the I/O to the processors at a rate of up

to 8 GB/sec. aggregate bandwidth per link, enabling a peak bandwidth of 24 GB/sec. per processor. The AMD Opteron processor with HyperTransport Technology provides a scalable direct connection between processors, I/O subsystems, and other chipsets. HyperTransport technology helps reduce the number of buses in a system, which can reduce system bottlenecks and enable today's faster microprocessors to use system memory more efficiently in high-end multiprocessor systems.

Memory Interface

In traditional x86 Northbridge/Southbridge architectures, processors share a memory controller and are not directly connected to one another. Memory transactions must propagate through the Northbridge chip fabric. This presents a bottleneck at the front-side bus that greatly reduces productivity and performance potential. In a Direct Connect Architecture, each CPU has its own integrated memory controller, which allows for more linear, symmetrical multiprocessing and optimized memory performance. This direct connection to the memory controller significantly reduces the memory latency seen by the processor. Latency will continue to drop as the processor frequency scales.

Additionally, hardware and software memory pre-fetching mechanisms can further reduce the effective memory latency seen by the processor. This reduction in memory latency, coupled with the additional increase in memory bandwidth available directly to the processor (resulting from this platform architecture design optimization), is critical, as it greatly enhances system performance across all application segments.

Chip-to-Chip Interconnect

Current interface schemes offer throughput performance from 266 MB/sec. to 1 GB/sec. Although desktop platforms may find these rates sufficient, workstation, server, and other future platforms require a more robust interface. The simultaneous integration of high-speed technologies (such as Gigabit Ethernet, PCI-X, and the InfiniBand Architecture) onto high-end platforms will quickly dwarf the bandwidth capabilities of existing interfaces. Direct Connect Architecture using HyperTransport Technology provides a high-speed, chip-to-chip interconnect that virtually eliminates the I/O performance bottleneck while providing ample performance headroom for future growth.

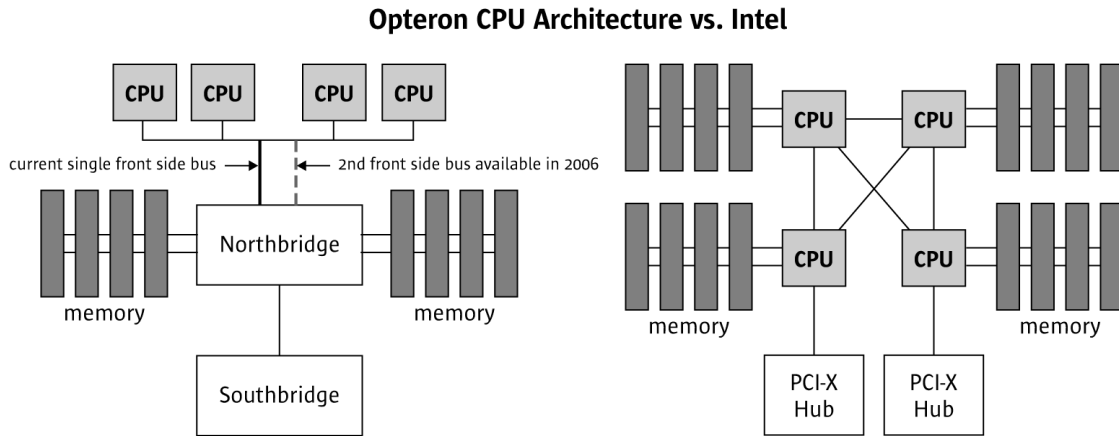


Figure 2-7: Intel vs. Opteron Architectures

I/O Expansion Capability to High-Speed Industry Buses

The traditional Northbridge/Southbridge architecture is not intended to support more than two core-logic elements. Adding additional high-speed functionality (such as Gigabit Ethernet, PCI-X, the InfiniBand Architecture, or any combination thereof) would have to occur in one of three ways:

- The functionality would have to be attached to an existing bus interface such as the PCI bus. However, an existing bus may not have sufficient bandwidth to support high-speed technologies, especially in instances in which multiple buses or combinations of buses must be supported simultaneously.
- The functionality would have to be directly attached to the higher speed proprietary chip-to-chip interconnect bus via a bridging device. However, the proprietary nature of this solution may limit the number of components available from vendors, thus impacting cost and availability.
- The functionality would have to be integrated into one of the core logic components. This solution is the least flexible, as a wide range of components would have to be created for each desired combination of feature-set buses.

HyperTransport Technology, an industry standard, provides system designers a high-speed, daisy-chained interconnect between system components. Specific components can be connected in a building-block fashion to achieve a platform with specific feature-set and performance objectives.

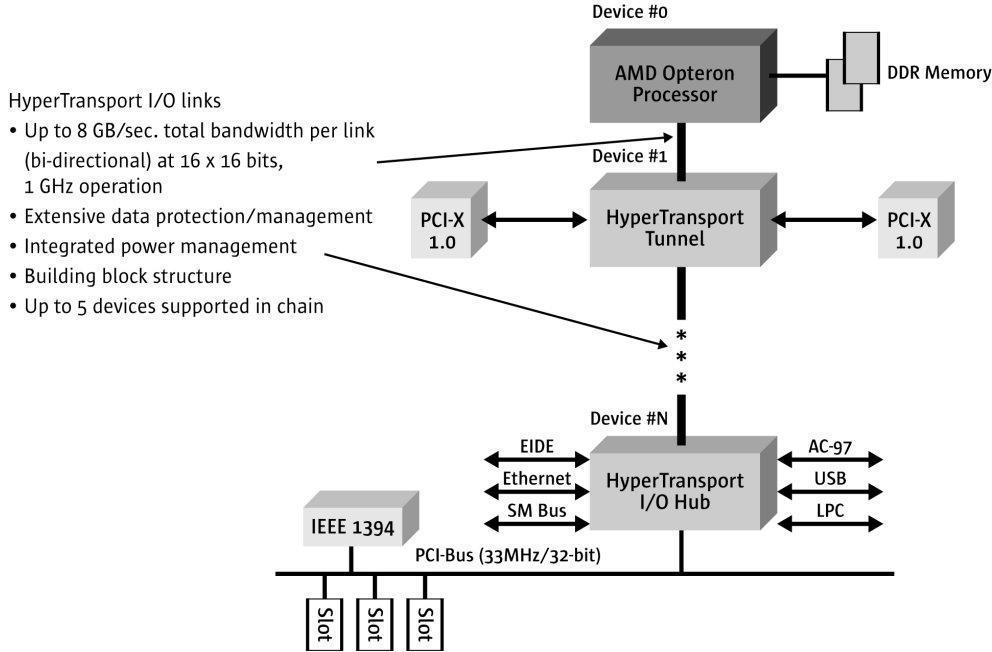


Figure 2-7: Sample HyperTransport Technology Architecture Block Diagram

Chapter 3

I/O Subsystem

Sun Fire X4600 I/O Subsystem Overview

The Sun Fire X4600 I/O subsystem is connected to the CPU complex through a HyperTransport link from processors A and H. The I/O subsystem consists of the following components:

- One tunneling HyperTransport bridge (AMD-8132 HyperTransport PCI-X Tunnels)
- A HyperTransport-attached Southbridge component (NVIDIA nForce4 Professional 2200)
- A HyperTransport-attached Southbridge component (NVIDIA nForce4 Professional 2050)
- Flash memory for the BIOS
- Additional motherboard embedded peripheral I/O consisting of:
 - One quad channel SAS RAID controller (LSI SAS1064) attached to one of the AMD-8132 PCI-X Tunnels on a shared bus with the PCI-X slot 0.
 - Two 10/100/1000 dual Gigabit Ethernet MAC/PHY devices (Intel FW82546GB NIC)
 - A video controller device attached to the PCI bus of the Southbridge (ATI Rage XL)
 - A Super I/O device connecting the Service Processor to the NVIDIA nForce4 Professional 2200 chip

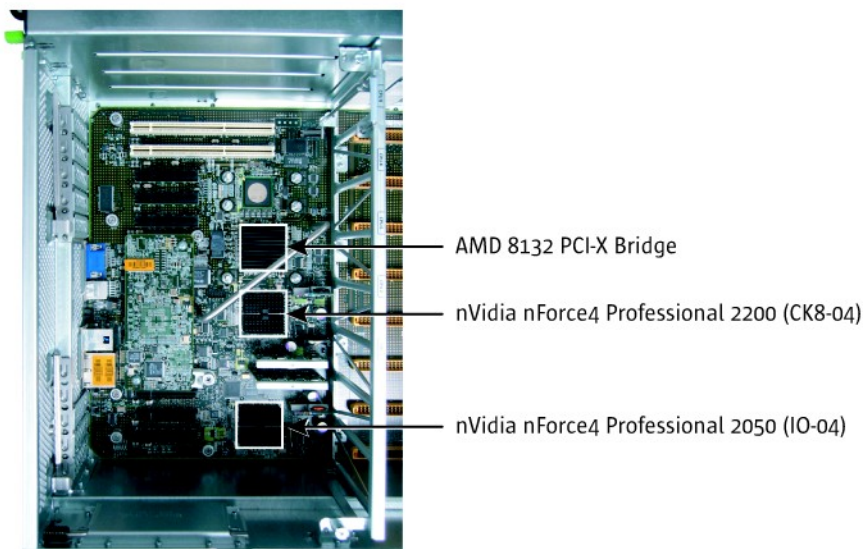


Figure 3-1: Sun Fire X4600 Subsystem

Chipsets

The Sun Fire X4600 Server chipsets architecture consists of:

- HyperTransport interconnects (previously discussed)

- AMD-8132™ HyperTransport PCI-X Tunnel
- NVIDIA nForce4 Professional 2200
- NVIDIA nForce4 Professional 2050

AMD-8132™ HyperTransport PCI-X Tunnel

The AMD-8132 HyperTransport PCI-X 2.0 tunnel is a high-speed device that provides two independent, high-performance PCI-X bus bridges, integrated with a high-speed HyperTransport technology tunnel. Designed for operation in modes 1 and 2, the AMD-8132 component brings high-performance PCI-X 2.0 connectivity to AMD Opteron processor-based systems with increased throughput, improved RAS capabilities, robust data management, and enhanced HyperTransport technology connectivity. As shown in Figure 3-2, the front-end HyperTransport interface (Side A) provides a configurable 16-bit wide communication path to the host, offering up to 8 GB/sec. of aggregate bandwidth. Similarly, the back-end HyperTransport interface (Side B) provides a configurable 16-bit wide communication path to a downstream device, offering up to 8 GB/sec. of aggregate bandwidth.

The AMD-8132 HyperTransport PCI-X Tunnel provides high-speed PCI-X capability and offers the following features:

- 16-bit HyperTransport interfaces (Side A and B) offering a maximum aggregate bandwidth up to 8 GB/sec. on each side
- Two PCI-X bridges (A and B), each of which supports a 64-bit data bus
- Each bridge also supports Mode 1 PCI-X, conventional PCI protocol, and Mode 2 operation
- Each bridge supports independent transfer rates and operational modes:
 - In PCI-X Mode 1, bridges support transfer rates of 133, 100, 66, and 50 MHz
 - In PCI mode, bridges support transfer rates of 66, 50, 33, and 25 MHz
- 37.5 x 37.5 mm, 829-pin BGA package
- 3.3 volt PCI-X signaling; 1.2 volt link signaling; 1.8 volt core

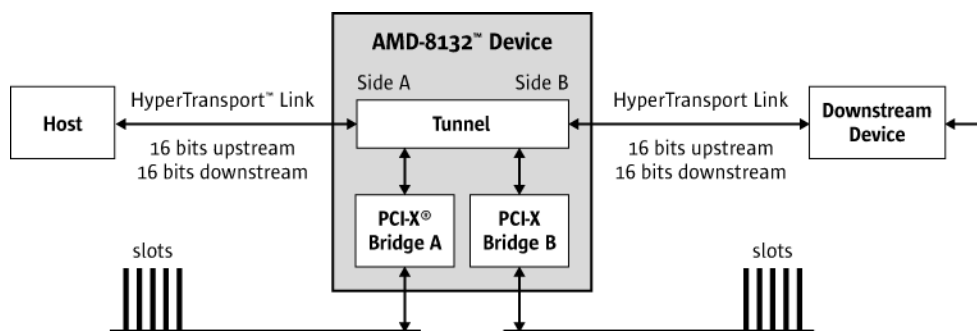


Figure 3-2: AMD-8132 HyperTransport PCI-X Tunnel Architecture Block Diagram

NVIDIA nForce Professional

The Sun Fire X4600 also uses the following NVIDIA nForce Professional chipsets:

- NVIDIA nForce 2200
- NVIDIA nForce 2050

Both the NVIDIA nForce Professional 2200 and NVIDIA nForce Professional 2050 MCPs (media and communications processors) provide I/O connectivity to a CPU via a 1-GHz, 8-GB/sec. HyperTransport connection. The NVIDIA nForce Professional 2200 attaches to the AMD 8132 PCI-X tunnel, while the NVIDIA nForce Professional 2050 attaches to CPU H.

The NVIDIA nForce Professional 2200 supports the following features:

- Three PCI-E ports (two 8-lane and one 4-lane)
- Independent IDE connection to DVD
- LPC connection to Super I/O
- Six USB 2.0 ports (three for external use and three for ILOM)
- PCI connection to ATI Rage XL

The NVIDIA nForce Professional 2050 supports the following features:

- Three PCI-E ports (two 8-lane and one 4-lane)

LSI SAS1064 SAS Controller

Sun Fire X4600 servers include an integrated LSI SAS1064 4-port 3-GB/sec. SAS HW RAID disk controller. The LSI SAS1064 is a versatile controller that provides 4 SAS ports capable of 3 GB/sec. data transfers for each phys, for a total maximum bandwidth of 12 GB/sec.

SAS features of the LSI SAS1064 include:

- Four fully independent phys
- Support for 3 GB/sec. SAS data transfers for each phys
- High-performance, serial, point-to-point, enterprise-level storage interface
- Simplified cabling between devices
- Data transfers using SCSI information units
- 133 MHz 64-bit PCI-X interface (shared bus with PCI-X 100 MHz slots)
- Integrated RAID0 and RAID1 solutions provide Integrated Mirroring technology and Integrated Striping technology

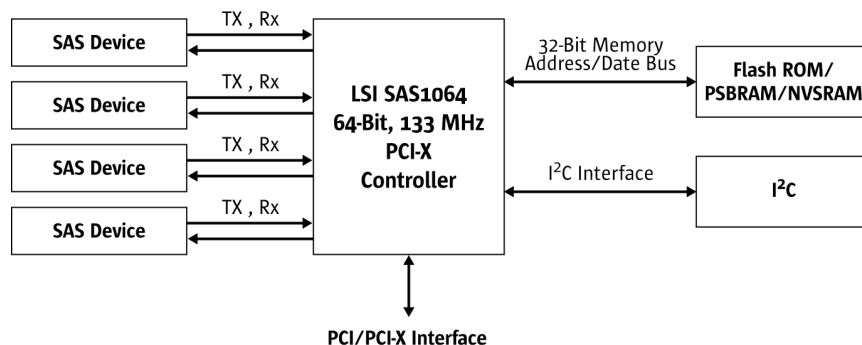


Figure 3-4: LSI SAS1064 Architecture Block Diagram

Although the LSI SAS1064 controller is capable of supporting both SAS and SATA drive types, the Sun Fire X4600 server will only support the SAS hard disk drives, which provide higher performance and better reliability. Currently, high-density, 10,000-RPM, 73-GB hard disks are supported.

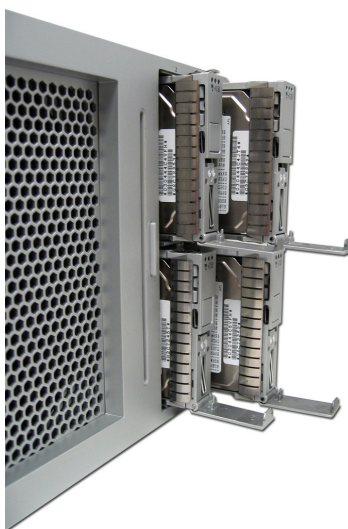


Figure 3-5: Sun Fire X4600 Hard Disk Drives

Intel 82546GB Dual Port Gigabit Ethernet Controllers

Sun Fire X4600 server is equipped with two Intel 82546GB Dual Port Gigabit Ethernet controllers that provide quad Gigabit Ethernet interfaces to the server platform. These servers are the first x64 rack-optimized servers available with four on-board Gigabit Ethernet ports for reducing network complexity. The Intel 82546GB Dual Port Gigabit Ethernet controller provides two 64-bit fully integrated Gigabit Ethernet Media Access Control (MAC) and physical layer (PHY) functions. It is capable of transmitting and receiving data at 10/100/1000MB/sec. data rate with half or full duplex capability. Additional features of the Intel 82546GB Dual

Port Gigabit Ethernet controller include:

- 802.3ab PHY compliance and compatibility (CAT-5 use)
- 802.3ab auto-negotiation
- 802.3x full-duplex flow control
- 802.9q VLAN tag insertion, stripping, and packet filtering
- Preboot eXecution Environment (PXE) Flash Interface support (32- and 64-bit)

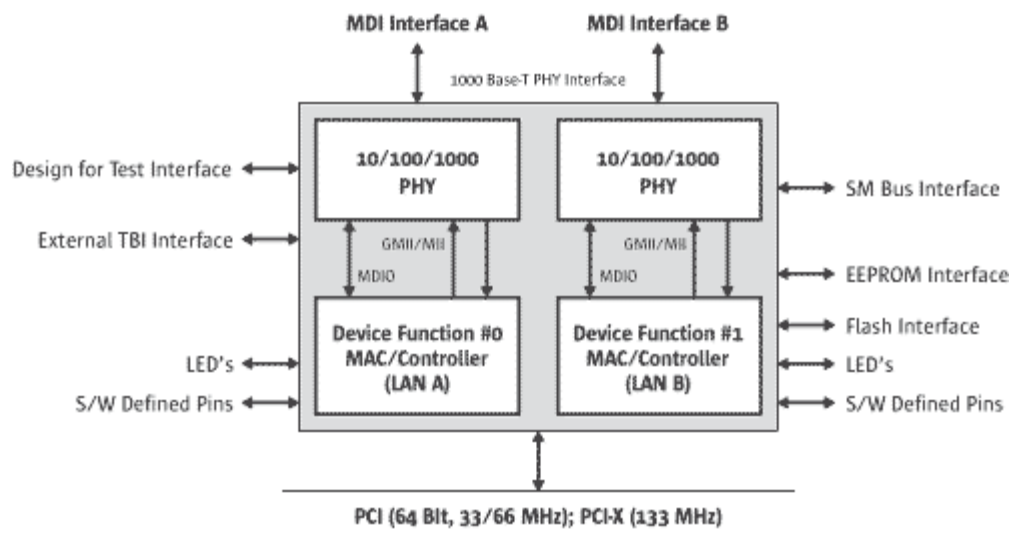


Figure 3-6: Intel 82546GB Dual Port Gigabit Ethernet Controller Architecture Block Diagram

ATI Rage XL Video

The Sun Fire X4600 server uses the ATI Rage XL graphics controller to deliver 2D and 3D graphics acceleration. The DVI port is connected to the service processor for remote graphics redirection. The ATI Rage XL has the following features:

- 64-bit 125 MHz memory clock
- 8 MB external memory
- 64-bit SDR (SDRAM/SGRAM) memory path
- 64-bit AGP/PCI bus
- Integrated TMDS: DVI, DFP, and VESA P&D interface
- Support for 24-bit TTL
- 1600x1200 maximum resolution
- 16.7M maximum color depth

- 1024x768 TMDS

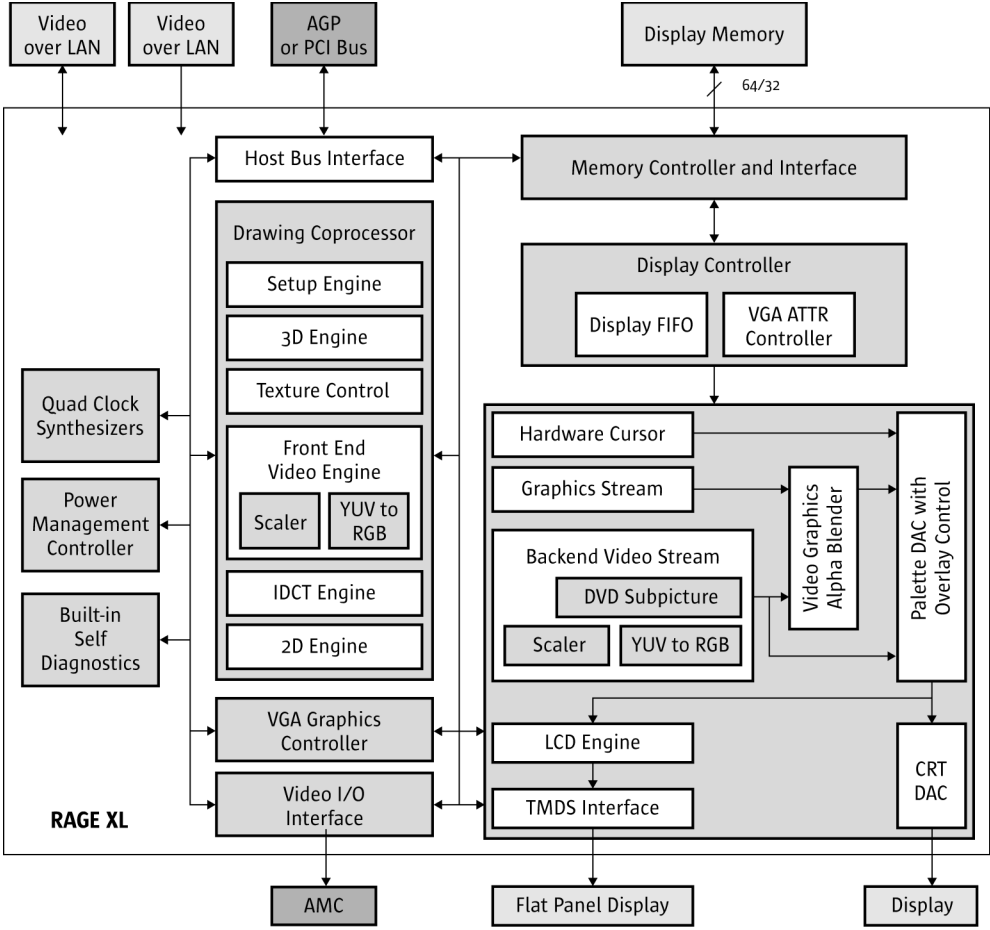


Figure 3-7: ATI Rage XL Architecture Block Diagram

SMSC LPC47B272 Super I/O Controller

The Super I/O device offers multiple I/O functions required to provide legacy I/O devices to the operating environment. On the Sun Fire X4600 servers, it provides the following:

- Floppy disk
- Serial port connection between SP and NVIDIA nForce Professional 2200

PCI-X and PCI-E Expansion Slots

The PCI slots on the Sun Fire X4600 server use a 3.3 Volt signaling bus. Therefore, they support only 3.3 Volt keyed expansion cards. The use of 5 Volt keyed expansion cards is unsupported and will result in damage to the motherboard.

The PCI-X slots accommodate expansion cards which adhere to the MD2 form factor standard. MD2 PCI-X cards are a maximum length of 169.3 mm (6.7 inches) and a maximum width of 51.5 mm (2.5 inches). The PCI-E slots accommodate expansion cards which adhere to the low profile form factor standard. Low profile PCI-E cards are a maximum length of 165.65 mm (6.65 inches) and a maximum width of 69.9 mm (2.731 inches).

Sun Fire X4600 Server PCI Expansion Slots

The Sun Fire X4600 server has eight PCI expansion slots: 2x PCI-X and 6x PCI-E. All eight slots are capable of 32- or 64-bit operation and support PCI or PCI-X and PCI-E expansion slots. The combination of PCI-X and PCI-E expansion capabilities enables more flexibility to support both legacy PCI/PCI-X connectivity as well as higher speed next-generation PCI-E interconnects for maximum I/O options and throughput.

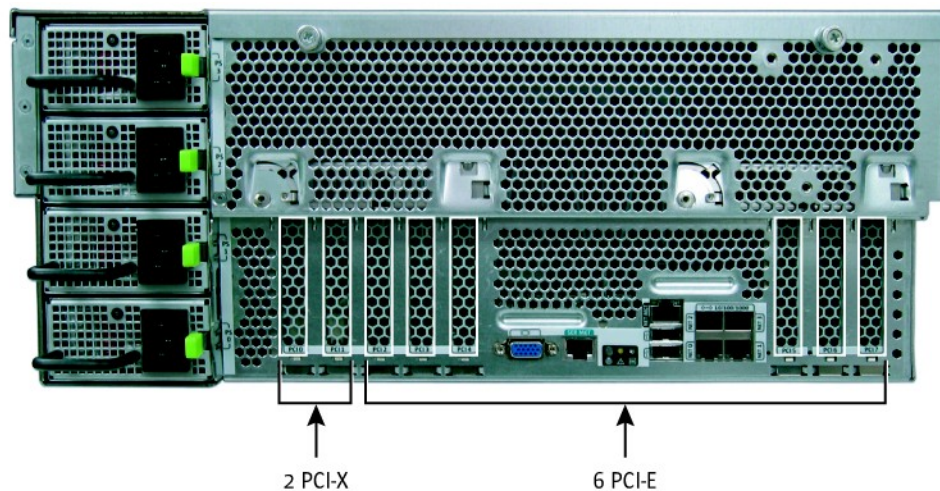


Figure 3-8: Sun Fire X4600 PCI Expansion Slots

From the rear of the server, the PCI-X slots are located in the leftmost position. The six PCI-E slots are oriented in two sets of three. While all PCI-E slots are implemented using x8 lane wide slots, there are electrical differences among the slots in terms of the bandwidth they support. As expected, the two left slots are x8 width, but the right slots in the trio are electrically x4 lane width. This physical x8 lane slot with x4 lane electrical connectivity is known as a soft 8 slot.

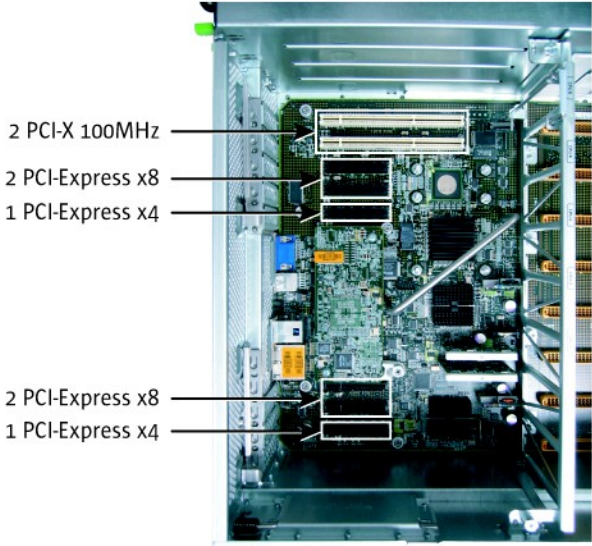


Figure 3-9: PCI Expansion Slot Locations

The two PCI-X slots have a maximum operational speed of 100 MHz. It is important to note that if an expansion card that operates at speeds less than 100 MHz is inserted into these slots, then the transfer speed along the entire bus will be degraded, affecting embedded disk performance. Since the shared bus speed will be lowered to the lowest common denominator, a 33 MHz expansion card will degrade performance more than a 66 MHz expansion card.

Chapter 4 Motherboard

All control and datapath functionality, with the exception of the disk connectors and CPU module boards, reside on the motherboard. There are sockets for connecting each of the 8 CPUs that are interconnected through AMD's HyperTransport™ technology. There are also HyperTransport links to the PCI-X bridge and the Southbridge chipsets. All external connections, with the exception of power, disks, and front panel I/O, come into the motherboard.

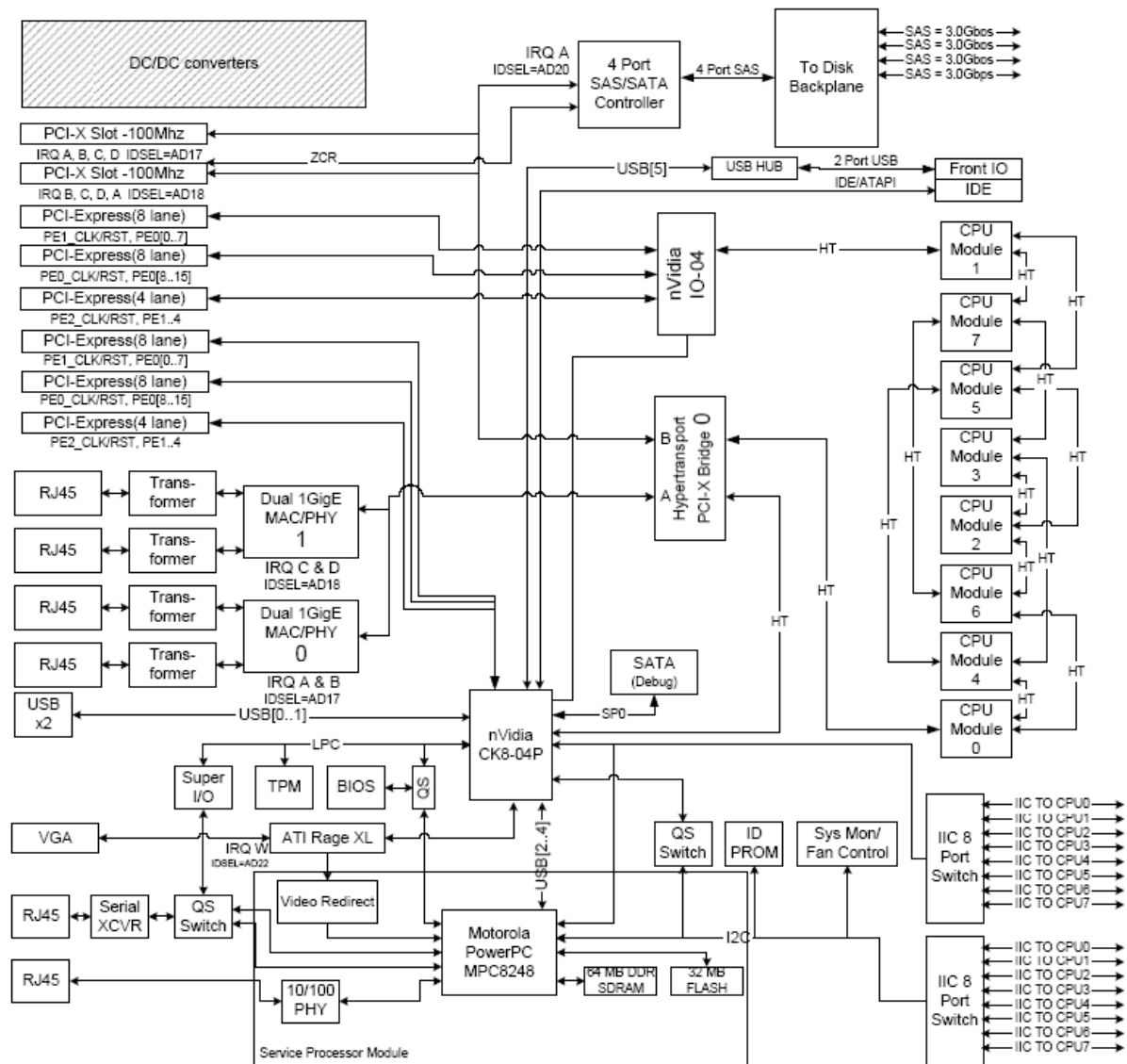


Figure 4-1: Sun Fire X4600 Motherboard Block Diagram

Chapter 5 Cooling and Power

Typical heat dissipation and power consumption metrics for a Sun Fire X4600 server equipped with eight Dual-core AMD Opteron processors and 32 GB RAM are as follows:

- UL Maximum Power: 1975 W
- Typical Power Consumption: 1400 W
- Typical Heat Dissipation: 5850 BTU/hr
- Ambient Temperature: 5-32 C

Cooling

The chassis of the Sun Fire X4600 server is segregated by an air divider into two distinct chambers: the motherboard/PCI and fan chamber and the Power Supply Unit (PSU) and storage chamber. Both areas are front-to-back air-cooled. The PSU and storage chamber is cooled by individual fans on the back of each power supply. Air is drawn through the front of the server by these rear-located fans. The motherboard/PCI and fan chamber is cooled by redundant rows of fans mounted in front of the server behind the bezel. Approximately 200 CFM of airflow is provided to cool the system.

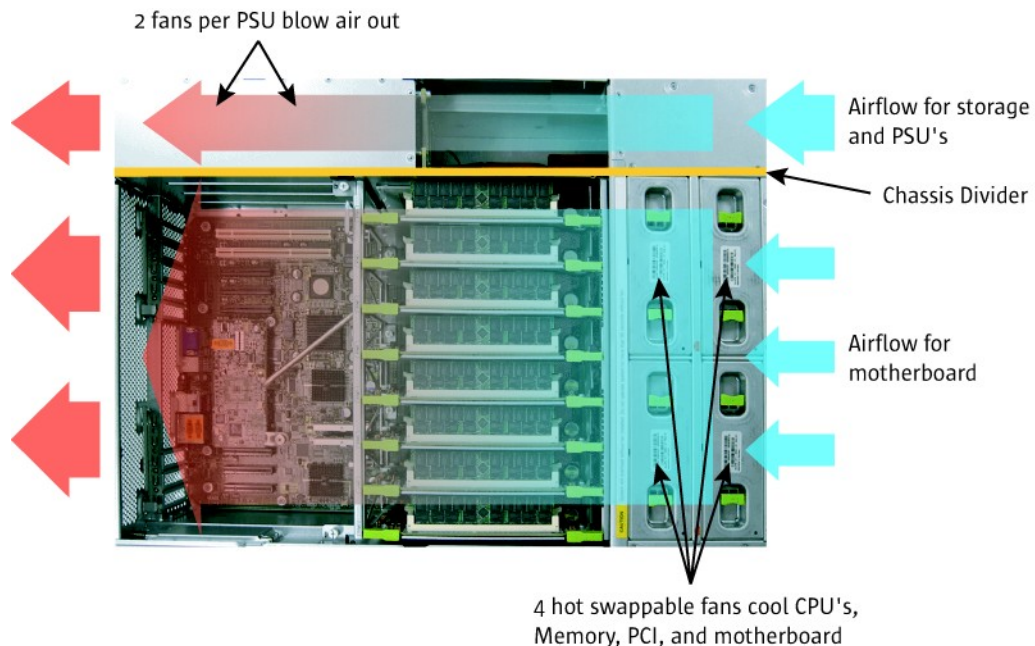


Figure 5-1: Airflow Diagram of Sun Fire X4600 Server

Because heat is so destructive to electronic components, lowering operating temperature will increase reliability. Sun's cooling design enables the CPUs to operate approximately 15% more efficiently.

Fans

Cooling fans in the Sun Fire X4600 server are positioned in two rows for redundancy just behind the front bezel. They are hot-swappable, and each fan module has an LED fault indicator. The fans are accessible from the top top of the server, which enables the fans to be accessed without interrupting system operation. Additionally, it makes it possible to service fans by only partially removing the server from the rack. This allows all cabling to remain in place and prevents disturbing any non-hot-swappable components.

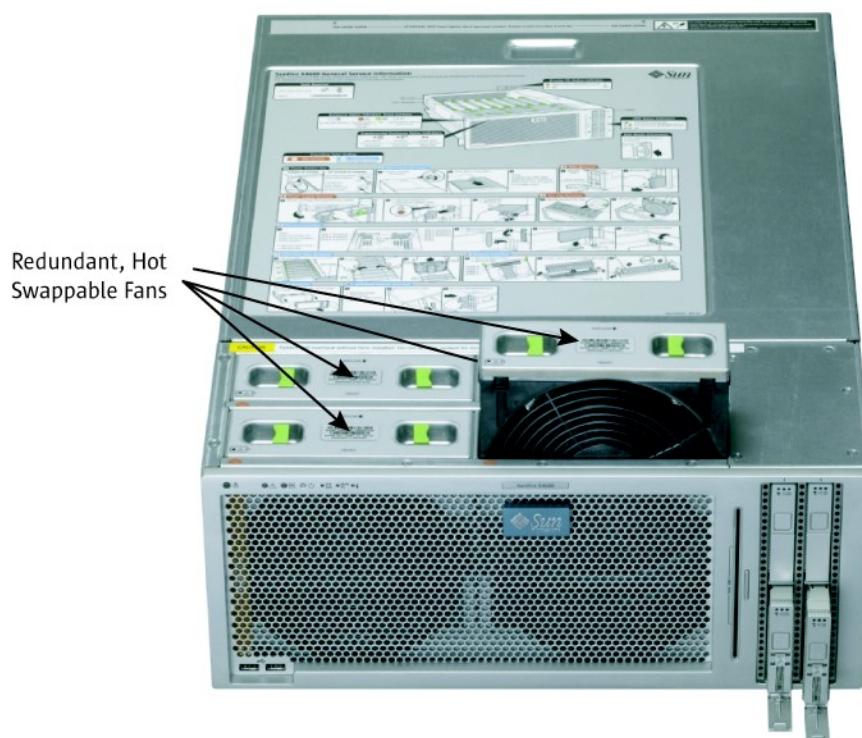


Figure 5-2: Sun Fire X4600 Cooling Fans

Fan speed is modulated by the Service Processor with Pulse Width Modulation by an ADM 1026 sensor chip. All fans are controlled with the same PWM frequency so they all operate at the same speed. The ADM 1026 device uses readings from three following three sensors to control the fan speed: Front Panel Ambient Temperature, CPU 0 Die Temperature, and CPU 1 Die Temperature. The Service Processor reads the fan speeds and turns the fan fault LED on if the RPM is under a set threshold.

Each row of fan trays is occupied by two fan modules for a total of four cooling fans. In a Sun Fire X4600 server, the fan modules are populated by 172 x 160 x 51mm fans.

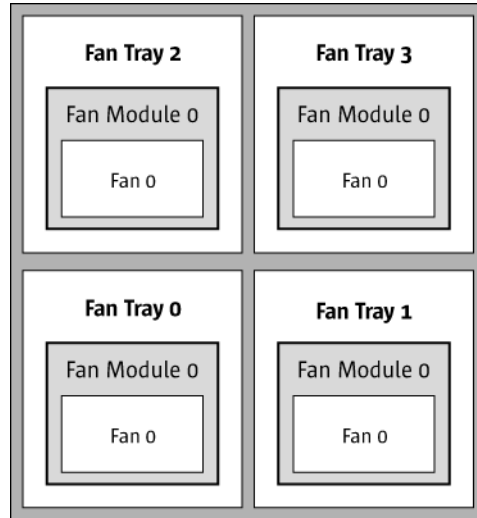


Figure 5-3: Sun Fire X4600 Server Cooling Fan Layout

Note: Do not operate the system for more than 60 seconds when a fan tray 2 or 3 is removed.

Power Supplies

The Sun Fire X4600 server is powered by dual redundant hot-swappable power supplies. The server requires four power supply units (PSUs) for N+N redundancy, but up to two PSUs to power the entire system. For optimal redundancy, two separate circuits should be used to eliminate dependence on a single electrical circuit and provide for consistent 2+2 redundancy with the PSUs themselves.

The new 950 watt high efficiency power supplies are shipped with each system that contain the 8-DIMM processor boards. This new power supply offers high power output to support 2+2 redundancy for a system with fully populated 8 processors and 64 DIMMs configuration. All other systems with 4-DIMM processor boards still have 850 watt power supplies. When upgrading the Sun Fire X4600 M2 from 4-DIMM to 8-DIMM processor boards, it is important to make sure the PSUs are upgraded from the 850 watt to the new 950 watt power supplies.

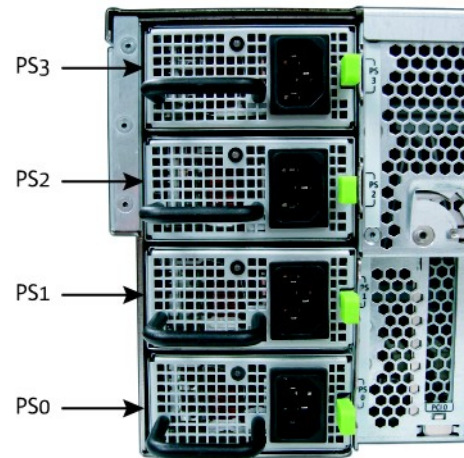


Figure 5-4: Sun Fire X4600 Power Supply Units

Power supplies are monitored and managed by ILOM. However, PSU fans are NOT individually managed by ILOM. Instead, they are considered part of the PSU unit. Therefore, a failure of a PSU fan is reported by ILOM as a failure of the entire PSU unit.

The power supplies have the following features:

- 850 Watts high efficiency PSUs for Sun Fire X4600
- 950 Watts high efficiency PSUs for Sun Fire X4600 M2
- Hot swappable
- 120/240 Volt – 50/60 Hz Autodetect
- 83% efficiency for the 850 Watt PSU
- 90% efficiency for the 950 Watt PSU
- N+N redundancy
- Two cooling fans

Chapter 6

ILOM: Integrated Lights Out Management

Integrated Lights Out Management (ILOM) is the Service Processor used in Sun Fire X4600 servers. ILOM enables multiple in-band and out-of-band management solutions. In-band management through the host operating system, or platform, is enabled by IPMI and SNMP OS-resident agents. Out-of-band management is enabled through the serial port or dedicated Ethernet. There is a command line interface (CLI) provided when out-of-band serial port connectivity is used. The dedicated Ethernet connectivity to out-of-band management features include:

- Web interface
- CLI via SSH
- IPMI 2.0
- SNMP v1, v2c, and v3

ILOM Architecture

The Sun Fire X4600 server leverages the same ILOM design and part used in the Sun Fire X4100 and X4200. ILOM is a Sun-designed Field Replaceable Unit (FRU) daughtercard. The ILOM daughtercard has the following features:

- Motorola MPC8248 PowerPC processor
- 32-bit 266 MHz
- 16 KB 4-way associative data cache
- 16 KB 4-way associative instruction cache
- 64-bit data bus
- 66 MHz PCI bridge
- 64 MB PC-133 MHz SDRAM
- 16-bit 32 MB Flash ROM
- DVI output
- USB connections to NVIDIA nForce Professional 2200
- LPC (Low Pin Count) connection to NVIDIA nForce Professional 2200
- 10/100 MB Integrated LAN
- Three serial ports (Debug, RS485, external)
- Half-size standard PCI form factor

The ILOM daughtercard is a standalone system with no dependencies on the operating system and has availability to physical interfaces through the connections listed above. The actual connected devices, however, are located on the main system board. ILOM daughtercard connections include:

- DVI output port connected to the ATI Rage XL via FPGA to enable remote graphics redirection from ILOM with a maximum VGA resolution of 1024 x 768.

- Three USB connections to the NVIDIA nForce Professional 2200 to provide remote keyboard, mouse, and storage functionality.
- LPC connection to the NVIDIA nForce Professional 2200 via FPGA.
- 10/100 MB Ethernet connected to the onboard Broadcom BCM5221 10/100 Ethernet controller, which automatically detects straight or cross-over Ethernet cables.
- External serial port multiplexed with the main system serial port for access to the ILOM CLI and system console using serial port redirection (S-o-L Serial-over-LAN).

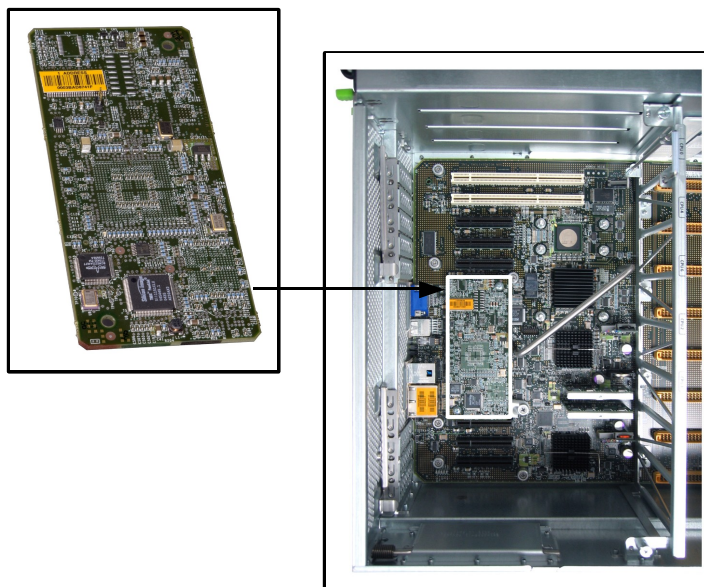


Figure 6-1: ILOM Daughtercard

ILOM Software

ILOM is an IPMI 2.0-compliant Baseboard Management Controller (BMC) that implements Lights Out Management (LOM), including “Remote Keyboard, Video, Mouse, and Storage” (KVMS), a Web management interface, a command line interface (CLI), and SNMP. ILOM software includes the following:

- Embedded, hardened Linux OS
- IPMI 2.0 BMC
- Platform Control agents diagnostics software
- RKVMS

The ILOM and BIOS firmware are easily upgraded using a single 11 MB file to upgrade both. The firmware upgrade can be performed either by command line interface or Web interface.

In-Band Server Management Interfaces

Server management through the platform operating system in a Sun Fire X4600 server is possible using either IPMI with a Keyboard Controller Style (KCS) interface and an IPMI kernel driver or by using SNMP OS-resident agents. IPMI 2.0 and SNMP v1, v2c, and v3 are the supported standards to perform autonomous platform management functions.

Baseboard Management Controller (BMC)

ILOM and its controlling firmware are together referred to as the Base Management Controller (BMC), which is the core of the IPMI structure. Tightly integrating an IPMI BMC and management software with platform firmware facilitates a total management solution.

Out-of-Band Server Management Interfaces

Server management through the ILOM service processor in a Sun Fire X4600 server is possible through serial port access or a dedicated Ethernet connection. Serial port connectivity to ILOM provides direct console access to the command line interface (CLI) and to the system console stream via serial port redirection, i.e., serial-over-LAN. The dedicated Ethernet interface offers ILOM connectivity by Web interface, CLI via SSH, IPMI 2.0, and SNMP v1, v2c, and v3.

Command Line Interface (CLI)

The ILOM command line interface is accessible either by a serial port connection or a dedicated Ethernet connection via Secure Shell (SSH) on a Sun Fire X4600 server. The CLI is designed to follow the Distributed Management Task Force Systems Management Architecture for Server Hardware (DMTF SMASH) Command Line Protocol (CLP).

The DMTF SMASH CLP is based on these concepts:

- Object namespace—There is a large namespace of objects to describe the targets for each command. Examples of objects are CLI users, SNMP traps, and alert rules.
- Command verbs—There are a small number of command verbs that operate on the objects in a namespace. Command verbs are simple and include create, delete, set, show, start, and stop.
- Object properties—An object may have one or more properties (parameters). For example, a user ID object has a password and roles properties.
- Options—A command may have options that modify or clarify its operation. The DMTF CLP lists several options that must be supported by all commands. The syntax of an ILOM command is

```
<verb> <options> <target> <properties>
```

Not all commands require options, a target, or properties to be specified.

The core of the model for the DMTF SMASH CLP is a hierarchical objects namespace in which an object in the namespace is a target to a command. There are two namespaces that an SP can reference: its own namespace, whose root is /SP, and the overall system namespace, whose root is /SYS. The purpose of the /SP namespace is to represent configuration and state for the SP. The primary purpose of the /SYS namespace is to allow access to sensors and other information about system hardware by the SP.

Web Interface

The Sun Fire X4600 ILOM Web interface supports both secure (https) and non-secure (http) access. Secure access will be enabled by default. The Web interface provides the same functionality as the CLI and is divided into five main sections:

- System Information
- System Monitoring
- Configuration
- Remote Controller
- Maintenance

Remote Keyboard, Video, Mouse, and Storage (RKVMS)

Remote Keyboard, Video, Mouse, and Storage (RKVMS) features are accessible through the ILOM Web interface.

Remote video display is accomplished through the ILOM Remote Console, which is a Java™ Web Start application. ILOM Remote Console is downloaded from ILOM to the management console machine and executed locally. It does not run on the server and therefore does not put overhead on the host. ILOM Remote Console is used to redirect the BIOS and setup screens as well as all other platform video output. It provides a true remote video console to the management console by handling the input and output to and from virtual devices and the Sun Fire server. The ILOM Remote Console supports 8- and 16-bit video display up to 1024 x 768 and requires the installation of Java Runtime Environment 5.0 on the management console.

The three USB ports connected between the ILOM service processor and the NVIDIA nForce Professional 2200 enable the remote keyboard, mouse, and storage components of the RKVMS functionality. The remote devices are presented to the Sun Fire server by ILOM Remote Console and ILOM as virtualized local devices.

ILOM Remote Console captures keyboard and mouse input on the management console and directs it to ILOM. ILOM then transmits these keyboard and mouse inputs over the USB ports to the NVIDIA nForce Professional 2200 and to the Sun Fire server. The Sun Fire server interprets these inputs as originating from local USB devices.

ILOM Remote Console is also capable of presenting remote bootable storage to ILOM and the Sun Fire server.

The remote storage can be either physical storage devices or bootable media image files on the hard drive. The following types of remote storage are supported by the ILOM Remote Console:

- CD/DVD-ROM
- Floppy
- CD/DVD-ROM image (.iso files)
- Floppy image (.img files)

When the Sun Fire X4600 server attempts to access a Virtual Floppy or Virtual CD-ROM as set up in the BIOS, ILOM redirects this access request to the ILOM Remote Console. The ILOM Remote Console then accesses the virtual disk content from the management console's physical CD/DVD-ROM drive, physical floppy drive, or a disk image on the hard drive. ILOM virtualizes this remote storage to the Sun Fire server using the USB ports connected to the NVIDIA nForce Professional 2200. The virtualized storage is recognized by the Sun Fire server as local USB connected storage and enables remote operating system boot up and installation.

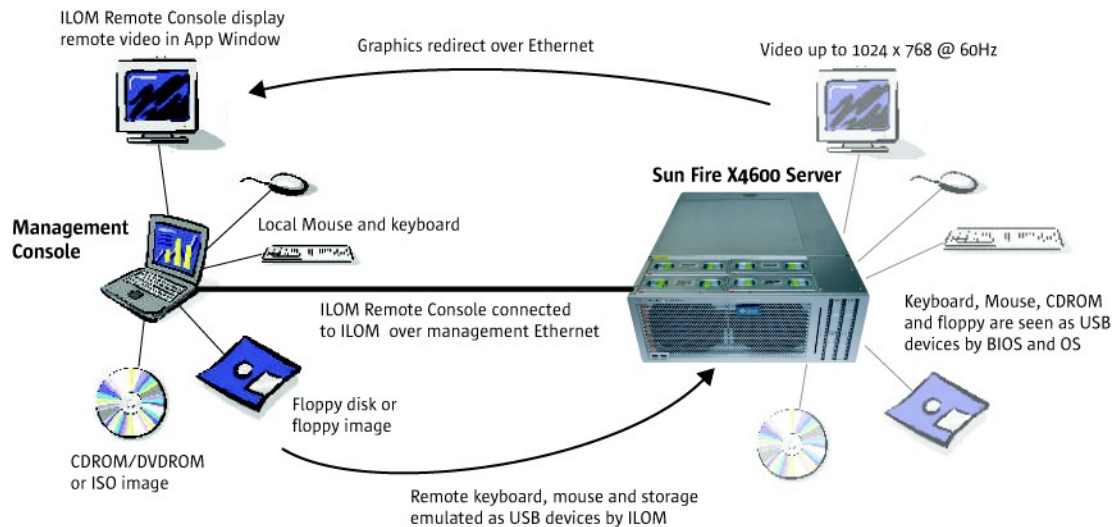


Figure 6-2: Illustration of RKVMS Functionality

Lights Out Management (LOM)

Lights Out Management is performed on the Sun Fire X4600 server through IPMItool, a command-line utility for controlling IPMI-enabled devices.

Intelligent Platform Management Interface (IPMI)

Platform management refers to the autonomous monitoring, logging, recovery, and inventory control features

implemented in hardware and firmware. The key differentiator of Intelligent Platform Management is that these functions are independent of the main CPU, BIOS, and OS. There are two major components of platform management: the Service Processor (or BMC) and System Management Software (SMS). Intelligent Platform Management capabilities are a key component in providing enterprise-class management for high-availability systems. Platform status information can be obtained and recovery actions initiated under situations where system management software and normal in-band management mechanisms are unavailable.

The Service Processor is the brain behind platform management. Its primary purpose is to provide autonomous sensor monitoring and event logging features. Typical sensor-related events are out-of-range temperature or voltage and fan failure. When an event occurs, it is noted in the system event log and made available to SMS. The Service Processor is powered by the power supply stand-by voltage and will function even when the server is powered down or the operating system has crashed. This allows platform status to be obtained and recovery initiated under situations in which in-band delivery mechanisms are unavailable. In modern systems, the Intelligent Platform Management Interface provides a hardware-level interface specification for monitoring and control functions. It defines a standard, abstract, message-based interface between the BMC and SMS and a common set of commands for operations such as accessing sensor values, setting thresholds, logging events, and controlling a watchdog timer. IPMI messages can be used to communicate with the BMC over serial and LAN interfaces, so software designed for in-band (local) management can be re-used for out-of-band (remote) management simply by changing the low-level communications layer.

IPMItool

IPMItool is a simple command-line interface to systems that support the IPMI v2.0 specification. IPMItool provides the ability to read the sensor data repository and print sensor values, display the contents of the system event log, print field-replaceable unit information, read and set LAN configuration parameters, and perform remote chassis power control. IPMItool was originally written to take advantage of IPMI-over-LAN interfaces but is also capable of using the system interface as provided by a Linux kernel device driver such as OpenIPMI or a Solaris™ driver called BMC, which is included in Solaris 10. IPMItool is available under a BSD-compatible license. System Management Software is generally complex and makes platform management only part of a much larger management picture. However, many system administrators and developers rely on command-line tools that can be scripted and systems that can be micro-managed. IPMItool takes a different approach to SMS and provides a completely command-line oriented tool. Therefore, it is not designed to replace the OpenIPMI library. Where possible, IPMItool supports printing comma-separated values for output to facilitate parsing by other scripts or programs. It is designed to run quick command-response functions that can be as simple as turning the system on or off or as complex as reading in the sensor data records and extracting and printing detailed sensor information for each record.

SNMP

SNMP management provides remote access by SNMP-compliant entities to monitor and control network

devices and manage configurations, statistics collection, performance, and security on a network. SNMP is a network management protocol used almost exclusively in TCP/IP networks. The Sun Fire X4600 servers provide SNMP MIBs to manage and monitor the servers using any SNMP-capable network management system, such as HP OpenView Network Node Manager (NNM), Tivoli, CA Unicenter, or IBM Director. The MIB data describes the information being managed, reflects current and recent server status, and provides server statistics.

SNMP v1, v2c, and v3 are supported. v1 and v2c are disabled by default, leaving v3 enabled by default. SNMP sets can be enabled or disabled. SNMP sets are disabled by default. An IPMI-specific trap, called a Platform Event Trap, or PET, may also be generated.

Sun N1 System Manager

In today's rapidly growing and constantly changing data centers, customers are deploying large number of systems to scale out their computing environments. As the number of systems in an organization grows, the complexities of managing a system infrastructure through its life-cycle become increasingly apparent. A server could be re-provisioned many times in its lifetime to support the changing business needs. For example, its role could change from an application host to a database server, or move from a staging site into a production environment. And once the systems are provisioned, IT operators must continuously monitor and manage them to ensure that they perform at desired levels.

Managing each step of the infrastructure life-cycle is challenging for even the most sophisticated IT staff. N1 System Manager is specifically designed to solve this problem with its comprehensive infrastructure life-cycle management capabilities. Customers can manage hundreds of Sun Fire x64 and SPARC servers in a heterogeneous environment from anywhere on the Web.

N1 System Manager enables IT organization to speed up system deployment, improve efficiency, increase responsiveness, and lower operating costs. It simplifies the discovery, provisioning, monitoring, updating and management processes for the life-cycle of Sun systems.

The key features of N1 System Manager include:

- **Hybrid user Interface** – a unique and innovative Web user interface with both GUI and CLI capabilities for performing management tasks.
- **Bare Metal Discovery** – discovers compute nodes based on their subnet or IP address with minimal manual intervention.
- **Systems Grouping** – groups systems together according to business requirements. Operators can

manage a group in the same manner as managing a single system.

- **Software Provisioning** – provisions Solaris, Linux, and Windows OS, as well as firmware and software updates, from a single Web console.
- **Hardware and OS Monitoring** – monitors hardware components and OS attributes to ensure the health of a system. Operators can customize the alarm thresholds for each component to meet business needs.
- **Event Notification** – notifies IT staff immediately upon detecting alarmed condition to take corrective actions.
- **Lights-out Management** – operators can remotely power systems on and off, execute commands, and access serial console to perform management tasks.
- **IT Roles** – assigns role to IT staff for granting responsibilities to manage systems.

Chapter 7

Software Operating Environment

The Sun Fire X4600 server supports multiple 32-bit and 64-bit operating systems, including Solaris, Linux, and Windows. The pre-installed Solaris 10 01/06 image also includes the patch 119851-13 to enable the use of the `raidctl` command for RAID configuration. VMware ESX Server compatibility and certification is planned for inclusion in the ESX Server 3.01 release in Q3CY06. Table 7-1 lists the different operating systems supported on the Sun Fire X4600 server.

Table 7-1: Sun Fire X4600 Supported Operating Systems

Operating System		Sun Supported
Solaris 10 01/06 on x64	64-bit	Yes
Red Hat Enterprise Linux 4.0 U3	64-bit	Yes
SuSE Linux Enterprise Server 9 SP3	64-bit	Yes
SuSE Linux Enterprise Server 10	64-bit	Planned
Microsoft Windows Server EE/SE 2003	32-bit	Yes
Microsoft Windows Server EE/SE 2003	64-bit	Yes
VMware ESX Server 3.0.1	64-bit	Yes, Nov 2006

Table 7-1: Sun Fire X4600 M2 Supported Operating Systems

Operating System		Sun Supported
Solaris 10 01/06 on x64 (U1)	64-bit	Yes
Solaris 10 06/06 on x64 (U2)	64-bit	Yes
Solaris 10 11/06 on x64 (U3)	64-bit	Yes
Red Hat Enterprise Linux 3.0 U8	64-bit	Yes (128GB limit, 8 cores)
Red Hat Enterprise Linux 4.0 U3	64-bit	Yes
Red Hat Enterprise Linux 4.0 U4	32/64-bit	Yes
Red Hat Enterprise Linux 5.0	64-bit	Yes
SuSE Linux Enterprise Server 9 SP3	64-bit	Yes
SuSE Linux Enterprise Server 10	64-bit	Yes
Microsoft Windows Server EE/SE 2003, SP1, SP2	32-bit	Yes
Microsoft Windows Server EE/SE 2003	64-bit	Yes
VMware ESX Server 3.0.1	32/64-bit	Yes

Solaris 10 on x64, Red Hat Enterprise Linux, and SuSE Linux Enterprise Server operating systems can be ordered from Sun. Sun provides support contracts for these operating systems running on the Sun Fire X4600 as well as Microsoft Windows Server 2003 Enterprise/Advanced Server Editions 32/64-bit, SP1, and SP2.

Solaris Operating System Features

Solaris 10 delivers performance advantages for database, Web, and Java technology-based services, as well as massive scalability with price/performance advantages. The following are features of the Solaris 10 operating system:

- Real-time troubleshooting of system problems

- New tools for low-level system debugging
- System hardware testing and analysis
- Fine-grained project accounting
- Enhanced patch analysis and delivery tools
- Existing applications benefit from Solaris 10 enhancements without modification
- Integrated Sun Java™ Enterprise System suite components and the Sun Java Desktop System
- 187 of the most popular free and open source software packages, many of which are supported by Sun
- Integrated developer tools such as GNU utilities and Perl and Python programming languages

Note: All occurrences of Solaris 10 OS for the Sun Fire X4600 server refers specifically to Solaris 10 for x64 OS, which is the minimum required Solaris release for the Sun Fire X4600 server.

Key Productivity Features

The Solaris Operating System delivers several critical performance and reliability features, such as:

- Enhanced ease of use and PC-interoperability features
- Integrated, high-performance Java technology and tools
- Robust software developer environment
- Advanced, standards-based networking
- Improved systems installation and management tools
- Enterprise-class directory services
- Enhanced desktop tools, I/O standards, and security

Other key features include:

- 100% binary compatibility
- Reliability, availability, and serviceability
- Java 2 SDK
- IPv6/IPsec/Mobile IP
- LDAP directory services
- System management tools
- Desktop management and productivity tools
- Observability
- Internationalization
- Data management
- Real-time application support
- Enhanced security features

Manageability Features

The Solaris 10 Operating System dramatically improves the way system administrators and developers identify

the reasons for suboptimal system and application performance. Solaris Dynamic Tracing (DTrace) technology makes it possible to delve deeply into today's complex systems to troubleshoot problems in real time and quickly eliminate bottlenecks. Additional Solaris 10 features provide enhanced system insight, enabling a system administrator to quickly identify and resolve hardware problems and streamline and automate patch management. Solaris Containers can also consolidate multiple applications onto a single system to increase utilization rates and cut system and licensing costs.

Existing applications that adhere to the Solaris x64 OS application binary interface (ABI) and that are compiled with the same APIs will run unmodified on x64 platforms. In addition, Sun provides an easy-to-use AppCert testing tool for developers to verify existing Solaris OS application binaries and report any potential incompatibilities.

Interoperability

Understanding that businesses today rely on a mix of technologies from a variety of vendors, Solaris 10 provides tools to enable seamless interoperability with hundreds of heterogeneous hardware and software platforms.

Availability

New Solaris 10 features, such as Predictive Self Healing, offer capabilities that automatically diagnose and recover from hardware and application faults, maximizing system uptime.

Advanced Networking

Support for IPv6 in the Solaris OS is integrated into NFS, RPC, NIS, NIS+, and DNS. IPsec enables secure virtual private networks and network access control. Mobile IP provides Internet disconnect/reconnect capabilities with no data loss.

Bundled Software

Software bundled with the Solaris OS includes Oracle 8i Enterprise Edition, Ixrun for Linux application compatibility (for the Solaris OS x64), Apache Web Server, Netscape Communicator, Sun Java System Directory Server, gzip, bash, and tcsh.

The Solaris operating environment ships with a number of software components that increase overall availability, including Solaris Resource Manager software for fine-grained control of system resources, Solaris Bandwidth Manager software for enhanced network resource availability, and Sun Cluster 3.1 software for even greater application availability through a clustered file system, scalable data services, and built-in load balancing.

Sun Studio (90-Day Trial Version)

Sun Studio 10 software is Sun's latest and best developer tool suite for C, C++, and Fortran application development. It continues to provide corporate developers and ISVs with a comprehensive, integrated suite of tools for the development, debugging, tuning, and deployment of enterprise applications on Sun platforms. With this release, Sun Studio 10 software extends its world-class development environment to the AMD64 architecture and delivers reliable, scalable, and high-performance applications for the Solaris 10 Operating System.

Additionally, Sun Studio 10 software provides a common debugger that can visually debug single and multi-threaded C, C++, and Fortran code. It can even handle intermixed Java and native code—an industry first! All of these powerful tools are presented within a NetBeans™-based Integrated Development Environment.

Sun Studio 10 software also provides an integrated development environment (IDE), performance analysis tools, and intuitive debugger for Linux operating systems. These components are compatible with GCC 3.2 software. Note that Sun is not supplying or providing support for the gcc compiler.

Customers using prior software versions, including Forte Developer 6 Update 2, Sun ONE Studio 7 Enterprise Edition, Sun Studio 8, and Sun Studio 9 releases, can easily upgrade to Sun Studio 10 software since it is fully compatible with these previous releases. The software is full of productivity enhancements, feature improvements, and expanded platform support to make Solaris and Linux application development more productive.

Solaris Flash Software

To improve utilization of the systems that make up today's data centers, administrators are turning to tools such as Solaris Flash software. Solaris Flash software provides new provisioning functionality that allows administrators to capture a snapshot image of a complete system—including the Solaris OS, the applications stack, and the system configuration—in a new Flash Archive format. Using this system image, administrators can then rapidly replicate a reference system configuration onto many target systems. Solaris Flash images can be deployed via standard media or over the network via HTTP and NFS protocols. Solaris Flash software images can be installed using custom Solaris JumpStart™ software scripts, through the Solaris Web Start software graphical interface, or through interactive installation of the Solaris Operating System.

Solaris LIVE! Upgrade Software

Solaris LIVE!™ Upgrade software allows Solaris OS software to be installed on a separate partition from the currently running version of the operating environment. In particular, Solaris LIVE! Upgrade software enables systems to run uninterrupted while a system administrator installs a Solaris Flash archive or upgrades to a new version of the Solaris Operating System. As a result, downtime for upgrades is reduced to the time needed for a reboot. When installation is complete, a simple reboot enables the Solaris 10 OS to take control. Since Solaris LIVE! Upgrade software includes a version migration and fallback feature, organizations can also fall back to the previous release (again, through a simple reboot) without losing administration information.

Real-Time Video Creation and Broadcast Support

A Java Media Framework (JMF) technology player provides access to the latest industry-standard audio and video files, including MPEG1/2, QuickTime, VIVO, AVI, AIFF, GSM, WAV, RMF, AU, and MIDI.

Solaris 10 OS Bundled Desktop Environments

The following desktop environments are included with the Solaris 10 Operating System.

Common Desktop Environment (CDE) Enhancements

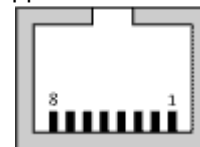
The latest generation of the Common Desktop Environment (CDE) comes standard, providing workstation users with an easy-to-use, open, secure platform. Personal Digital Assistant (PDA) support synchronizes data from most Palm computing devices with the CDE calendar, mail, memo, and address book. CDE now features streaming video using MPEG1, MPEG2, QuickTime, and AVI formats, as well as MIDI audio using Java Media Framework technology.

GNOME 2.0 Desktop Environment

GNOME 2.0, the modern desktop for the Solaris 10 Operating System (OS), provides applications and tools that are designed to enhance business productivity in a networked world. GNOME 2.0 helps organizations achieve their business goals by offering a unified, modern, open, networked, and cost-effective desktop solution. Key features of GNOME 2.0

include:

- Personalization capabilities that allow users to change settings to suit their preferences
- Built-in applications and assistive technology solutions for users with disabilities
- Removal of the complexity of supporting disparate desktop user environments and the provision of a richer common unified desktop
- Open file standards that provide transparent file and data interchange
- Built-in accessibility support that enables all users to interact with the GNOME 2.0 desktop environment running on any UNIX platform
- Flexibility and choice to run GNOME, CDE/Motif, and Java technology-based applications unmodified,



preserving existing software investments

- Support for key open standards to facilitate interoperability, compatibility, and collaboration in today's highly-networked, heterogeneous world, including support for XML, DOM, HTTP, HTML, CORBA, MIME, Unicode, MPEG, JPEG, AVI, MIDI, XDnD (drag & drop), X11, NFS, and TCP/IP

GNOME 2.0 for the Solaris OS is open source, free software with no upgrade or licensing fees. More information about GNOME 2.0 is available at <http://www.sun.com/gnome>.

Solaris OS Licensing and Usage

Under the Free Solaris™ Binary License Program, Sun is making the binary (runtime) version of its Solaris 10 OS available to anyone who accepts the terms of the Solaris OS Binary Code License (BCL) and the Free Solaris Binary License Program. There are no fees for the right to use the software on computers with a capacity of eight or fewer processors. There is a small charge for the media kit. Refer to <http://www.sun.com/software/solaris> for current licensing details.

Features of the Solaris OS license include the following:

- No distinction between desktop and server licenses
- Free binary (runtime) license for all systems with eight or fewer CPUs for users who accept the terms of the Solaris 10 OS Binary Code License and the Free Solaris Binary License Program
- Availability for purchase via the Solaris 10 Media Kit at <http://www.sun.com/solaris/binaries>
- Single Solaris Media Kit for installing multiple systems
- Solaris Media Kit containing additional bundled software
- Solaris Supplemental CD of bundled user and system management tools
- Oracle 8i Enterprise Edition (with development license)
- StarOffice™ 8.0 productivity suite
- Solaris Software Companion CD of popular freeware

Chapter 8

Additional Software Included

Sun Installation Assistant

The Sun Installation Assistant software on CD-ROM is included in the ship-kit with every Sun Fire X4600 server. Sun Installation Assistant is a Linux installation utility that reduces the complexity of installing supported Linux distributions on new hardware. A newly released platform seldom has a certified set of drivers already in a current Linux distribution. Typically, an administrator will be required to generate driver disks for each of the supported Linux distributions that he or she plans to install. Additionally, Linux distributions do not contain support for non-platform drivers such as the Service Processor.

A complete Linux installation on a Sun Fire X4600 server can be easily performed using the Sun Installation Assistant CD-ROM. Installation can be done either locally or remotely using the remote KVM features provided by ILOM and the ILOM Remote Console.

Once the system has been booted from the media or image, a boot kernel is loaded and probes the platform configuration. Upon recognition that the server is a supported platform, a list of the currently supported Linux distributions is displayed and the user is prompted to insert Disk 1 of the supported Linux distribution of his or her choice. Disk 1 can be either a physical CD-ROM disk or an ILOM Remote Console redirected iso disk image. The Linux distribution installation continues as usual until completion. Following installation completion, the certified platform and device drivers are installed and the installation is completed without necessitating cumbersome driver installation procedures. The Sun Installation Assistant manages the software installation of:

- Supported Linux operating systems
- Platform-specific software
- Diagnostic and fault management software
- Add-on components such as the JES middleware stack

Appendix A Connector Pinouts

USB

Table A-1: USB Pinouts

Pin #	Pin Name	Description
1	+5V	+5V supply
2	Data-	Negative side of differential pair for data
3	Data+	Positive side of differential pair for data
4	Gnd	Ground



Figure A-1: USB Pinouts

Serial

Table A-2: Serial Pinouts

Pin #	Pin Name	Description
1	CTS	Clear to Send
2	DCD	Data Carrier Detect
3	TXD	Transmit Data
4	GND	Ground
5	GND	Ground
6	RXD	Receive Data
7	DTR	Data Terminal Ready
8	RTS	Ready to Send

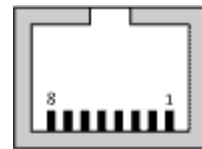


Figure A-2: Serial Pinouts

10/100 BaseT

Table A-3: 10/100 BaseT Pinouts

Pin #	Pin Name	Description
1	TX+	Positive Side of Transmit Data
2	TX-	Negative Side of Transmit Data
3	RX+	Positive Side of Receive Data
4	NC	No Connect

5	NC	No Connect
6	RX-	Negative Side of Receive Data
7	NC	No Connect
8	NC	No Connect

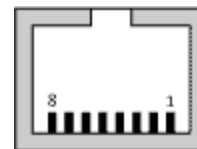


Figure A-3: 10/100 BaseT Pinouts

Serial Attached SCSI (SAS)

Table A-4: Serial Attached SCSI (SAS) Pinouts

Pin #	Pin Name	Description
Signal Segment		
S1	GND	2 nd mate
S2	TX+	Transmit from PHY to hard drive
S3	TX-	Transmit from PHY to hard drive
S4	GND	2 nd mate
S5	RX-	Receive from hard drive to PHY
S6	RX+	Receive from hard drive to PHY
S7	GND	2 nd mate
Backside Signal		
S8	GND	2 nd mate
S9		
S10		
S11	GND	2 nd mate
S12		
S13		
S14	GND	2 nd mate
Power Segment		
P1	3.3V	Not supported
P2	3.3V	Not supported
P3	3.3V	Not supported
P4	GND	1 st mate
P5	GND	2 nd mate
P6	GND	2 nd mate
P7	5.0V	Pre-charge, 2 nd mate
P8	5.0V	
P9	5.0V	
P10	GND	2 nd mate
P11	Reserved	Should be grounded
P12	GND	1 st mate
P13	12.0V	Pre-charge, 2 nd mate
P14	12.0V	
P15	12.0V	

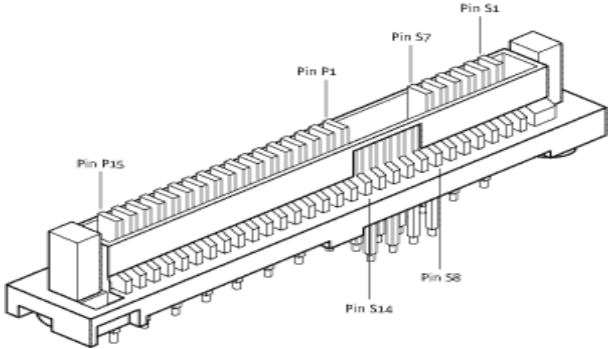


Figure A-4: Serial Attached SCSI (SAS) Pinouts

10/100/1000 BaseT

Table A-5: 10/100/1000 BaseT Pinouts

Pin #	Pin Name	Description
1	TPO+	Positive Side of Data Pair 0
2	TPO-	Negative Side of Data Pair 0
3	TP1+	Positive Side of Data Pair 1
4	TP2+	Positive Side of Data Pair 2
5	TP2-	Negative Side of Data Pair 2
6	TP1-	Negative Side of Data Pair 1
7	TP3+	Positive Side of Data Pair 3
8	TP3-	Negative Side of Data Pair 3

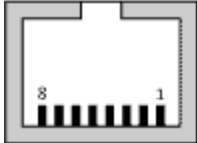


Figure A-5: 10/100/1000 BaseT Pinouts

VGA

Table A-6: VGA Pinouts

Pin #	Pin Name	Description
1	RED	Red Video
2	GRN	Green Video
3	BLU	Blue Video
4	ID2	(Ground)
5	GND	Ground
6	R_GND	Red Video Return (Ground)
7	G_GND	Green Video Return (Ground)
8	B_GND	Blue Video Return (Ground)

9	KEY	No Pin
10	S_GND	Syn Return (Ground)
11	IDO	IDO (Ground)
12	IDI	IDI (No Connect)
13	HSYNC	Horizontal Sync
14	VSYNC	Vertical Sync
15	ID3/SCL	No Connect

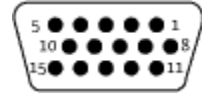


Figure A-6: VGA Pinouts

Appendix B

Sun Fire X4600/X4600 M2 Rack Mounting Specifications

Sun Fire X4600/X4600 M2 server should fit in nearly all 3rd-party racks that meet these criteria:

- Rack has a horizontal opening with unit vertical pitch conforming to ANSI/EIA 310-D-1992 and/or IEC 60927
- Four-post structure (i.e., mounting at both front and rear)
- Distance between front and rear mounting planes is between 610 mm and 915 mm (24 to 36 inches)
- Clearance depth (to front cabinet door) in front of front rack mounting plane is at least 25.4 mm (1 inch)
- Clearance depth (to rear cabinet door) behind front rack mounting plane is at least equal to the cable management arm
- Clearance width (between structural supports, cable troughs, etc.) between front and rear mounting planes is at least 456 mm (18 inches)

To permit installation in racks meeting the above criteria, there is only one rack slide and cable management arm set for the Sun Fire X4600 server. There is no provision in the slide brackets for mounting to non-standard side planes within rack cabinets—all mounting is to front and rear planes only.

For reference, most generic 19-inch format racks of 900 mm or greater overall depth can accommodate the Sun Fire X4600 server; the system will fit in some shallower racks and many at 800 mm without the cable management arm.

Note: Two-post, center-mount racks are not supported.

Appendix C

Sun Fire X4600/X4600 M2 Server Dimensions

The Sun Fire X4600/X4600 M2 server has the following size and weight dimensions.

Table B-1: Sun Fire X4600/X4600 M2 Server Dimensions

	Sun Fire X4600 and X4600 M2
Weight	106 lbs. / 48 Kg maximum with rack kit and cable mgmt arm 88 lbs. / 40 Kg maximum standalone server
Height	6.9 in. / 176 mm 4RU
Width	17.5 in. / 445 mm
Depth	24.75 in. / 629 mm chassis with bezel 25.25 in. / 642 mm chassis, bezel, and rear PSU latches

Appendix D

Environmental and Regulatory Compliance

The Sun Fire X4600 server meets or exceeds the following environmental and regulatory specifications.

Table C-1: Sun Fire X4600 Server Environmental Specifications

Type	Specification
Operating temperature (single, non-rack system)	10° C to 32° C (41° F to 90° F), 20% to 90% relative humidity, non-condensing, 27° C max wet bulb
Non-operating temperature (single, non-rack system)	-40° C to 65° C (-40° F to 149° F), up to 93% relative humidity, non-condensing 38° C max wet bulb
Operating altitude (single, non-rack system)	35° C up to 900 meters and a derating of 1° C for every 300 m in altitude, up to 3048 m maximum
Non-operating altitude (single, non-rack system)	Up to 12000 meters
Acoustic noise (single, non-rack system)	Less than 67 dB sound power in ambient temperature of up to 24° C 75 dB sound power in ambient temperature above 25° C

Table C-2: Sun Fire X4600 Server Regulatory Specifications

Type	Specification
Safety	IEC60950, UL/CSA60950-01, EN60950, CB Scheme with all country differences
RFI/EMI Immunity	FCC Class A, Part 15 47 CFR, EN55022, CISPR 22, EN 300- 386:v1.3.2, ICES-003 EN55024
Related Certifications: Safety	cULus Mark, TUV GS Mark, CE Mark, CCC, BSMI, GOST R, S-Mark
Related Certifications: EMC	CE Mark (93/68/EEC) Emissions and Immunity, Class A Emissions Levels: FCC, VCCI, BSMI, C-Tick, MIC, GOST
Other	Labeled per WEEE (Waste Electrical and Electronic Equipment) Directive



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